

THE DFVLR MAIN DEPARTMENT FOR CENTRAL DATA PROCESSING
1976-1983

Deutsche Forschungs- und Versuchsanstalt für
Luft- und Raumfahrt

(Division of Scientific and Technical Operating Equipment)

(NASA-TM-77314) THE DFVLR MAIN DEPARTMENT
FOR CENTRAL DATA PROCESSING, 1976 - 1983
(National Aeronautics and Space
Administration) 131 p HC A07/MF A01

N84-20196

Unclas

CSSL 09B G3/60 18597

Translation of "Hauptabteilung Zentrale Datenverarbeitung,
1976-1983," Deutsche Forschungs- und Versuchsanstalt
für Luft- und Raumfahrt, Oberpfaffenhofen,
West Germany. Report, Sept. 22, 1983,
pp. 1-163 + 7 pages of graphics.

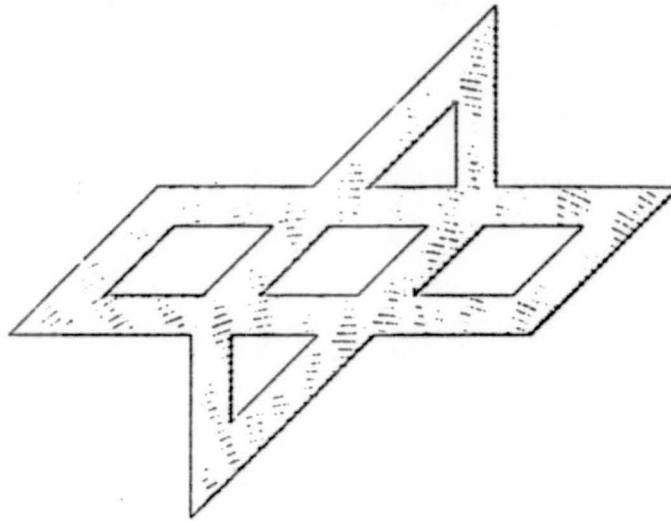


NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546
DECEMBER 1983

| | | | |
|---|--|--|-----|
| 1. Report No. NASA TM-77314 | 2. Government Accession No. | 3. Recipient's Catalog No. | |
| 4. Title and Subtitle THE DFVLR MAIN DEPARTMENT FOR CENTRAL DATA PROCESSING, 1976-1983 | | 5. Report Date December 1983 | |
| | | 6. Performing Organization Code | |
| 7. Author(s) Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Division of Scientific and Tech. Operating Equipment | | 8. Performing Organization Report No. | |
| | | 10. Work Unit No. | |
| 9. Performing Organization Name and Address Leo Kanner Associates Redwood City, California 94063 | | 11. Contract or Grant No. NASw-3541 | |
| | | 13. Type of Report and Period Covered Translation | |
| 12. Sponsoring Agency Name and Address National Aeronautics and Space Adminis- tration, Washington, D.C. 20546 | | 14. Sponsoring Agency Code | |
| | | | |
| 15. Supplementary Notes Translation of "Hauptabteilung Zentrale Datenverarbeitung, 1976-1983," Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Oberpfaffenhofen, West Germany. Report, Sept. 22, 1983, pp. 1-163 + 7 pages of graphics. | | | |
| 16. Abstract In this report, the Main Department for Central Data Processing of the DFVLR presents a summary of its work from 1976 to 1983.. The evolution of the Dept., and rationale behind it, constitute the focus of this retrospective overview. Areas of Main Dept. responsibility and endeavor are set forth, as these relate both to individual DFVLR sites and to the DFVLR system as a whole. | | | |
| 17. Key Words (Selected by Author(s)) | | 18. Distribution Statement Unclassified - Unlimited | |
| 19. Security Classif. (of this report) Unclassified | 20. Security Classif. (of this page) Unclassified | 21. No. of Pages | 22. |



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OF POOR QUALITY



Zentrale
Datenverarbeitung

1976-1983

D F W M R

Preface

In this report, the Main Department for Central Data Processing (formerly "Computing Center") of the Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt (DFVLR) presents a retrospective overview of its work from 1976 to 1983.

It is definitely not our intention that every reader read this report from cover to cover. Rather, we expect each reader to seek out those sections that seem particularly pertinent to his own purposes and interests. In keeping with this, we have tried to present the multi-faceted work of the Dept. for Central Data Processing in such a way as to be intelligible even to those readers who are not conversant with the details. We have therefore devoted more space to explanation of the hows, whys, and wherefores than to elaboration of minute details.

¹This status report was formatted and produced using the GML text processing system (see Section 10). The two preceding pages contain examples of computer-generated graphics produced at the Main Dept. for Central Data Processing (see Section 11).

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THE DFVLR MAIN DEPARTMENT FOR CENTRAL DATA PROCESSING
1976-1983

Deutsche Forschungs- und Versuchsanstalt für Luft-
und Raumfahrt, Division of Scientific and
Technical Operating Equipment

PART I: The DFVLR Main Department for Central Data Processing

/1*

1. The Main Department for Central Data Processing

/3

1.1 Point of Departure

Until 1976, each of the five DFVLR research centers had its own computing center. These computing centers were independent of one another, and each reported directly to the administrator responsible for that particular site. In addition, the GSOC (now the Hauptabteilung Raumflugmissionen) operated its own computing center for processing satellite data. One consequence of the decentralized administration of computing centers in the DFVLR was a total lack of uniformity in computer and software systems. Within the six computing centers in 1976, there were five different models of computers, manufactured by four different companies; five different operating systems were in force (Table 1).

TABLE 1. COMPUTER EQUIPMENT AND SYSTEMS IN THE DFVLR
COMPUTING CENTERS IN 1976.

| Site | Equipment | Operating System |
|------------------|-----------------------|------------------|
| Braunschweig | Siemens 4004-60 | BS1000 |
| Göttingen | IBM/370-158 | OS-VS2 (SVS) |
| Köln-Porz | Telefunken TR440 | BS3 |
| Stuttgart | Siemens 4004-55 | PBS |
| Oberpfaffenhofen | Telefunken TR440/TR86 | BS3 |
| GSOC | CDC 3800 | DRUM SCOPE |

The hard- and software of the aforementioned systems were almost totally incompatible with each other; interchange of programs as well as data was highly problematic, if not completely impossible. A user could utilize the data-processing system of another site only by traveling to that site and investing considerable time in becoming familiar with the system.

* Numbers in the margin indicate pagination in the foreign text.

Collaboration between DFVLR scientists was greatly hampered in /4 the process. A remedy was urgently needed.

1.2 Structure and Computing Equipment of the New Main Department for Central Data Processing

In 1976, therefore, the Main Computing Dept. was established, which united the five local computing centers into one organizational entity, incorporating them into the newly-formed Division of Scientific and Technical Operating Equipment. The computing centers were maintained as divisions of the new Main Dept. In addition, two new departments--Systems Planning and Development, and Applied Mathematics and Computer Science--were created, which were invested with functions on a system-wide level. Oberpfaffenhofen was chosen as the administrative seat of the new Main Dept.

The selection of hardware for the new Main Dept. was guided by the need for an efficient, uniform, and highly economical computing system. Plans therefore included:

- a large-capacity central computer
- smaller local computers with performance adequate for tasks at the local sites
- compatibility of all equipment as prerequisite for a DFVLR computer network

The wish of the DFVLR to ensure complete compatibility of all computing equipment and systems could not be realized, however, since the Bundesministerium für Forschung und Technologie (BMFT) [Federal Ministry for Scientific Research and Technology] insisted on the inclusion of equipment produced by a German manufacturer. There was no system available on the German market, however, with performance adequate for the central computer in Oberpfaffenhofen.

The DFVLR therefore chose the following equipment (Table 2).

TABLE 2. COMPUTER EQUIPMENT AND SYSTEMS IN THE DFVLR MAIN COMPUTING CENTER AFTER 1976.

| <u>Site</u> | <u>Equipment</u> | <u>Operating System</u> | /5 |
|------------------|------------------|-------------------------|----|
| Braunschweig | Siemens 7.755 | BS2000 | |
| Göttingen | IBM/370-158 | OS-VS2 (MVS) | |
| Köln-Porz | Siemens 7.755 | BS2000 | |
| Stuttgart | Siemens 7.748 | BS2000 | |
| Oberpfaffenhofen | Amdahl 470 V/6 | OS-VS2 (MVS) | |

The Amdahl 470 V/6 was chosen in spite of the fact that up to that point this computer was not in use anywhere outside the United States, and all such units in the United States had either been installed as adjuncts to IBM systems or had relieved IBM central processing units.

In 1982, two bureaus--Administrative Data Processing (VO-VBD) and Organization (VO-VBO)--which had formerly been under the direction of the executive office in Köln-Porz were assumed into the Main Dept. as a new division: Applications Software and Organization (DV-ASO), based in Köln-Porz. Concurrently, the Main Computing Dept. was renamed Zentrale Datenverarbeitung (WT-DV) [The Main Dept. for Central Data Processing] to reflect the broadened scope of its functions. Figure 1 illustrates the current structure of the Main Dept. and its geographic constituents.

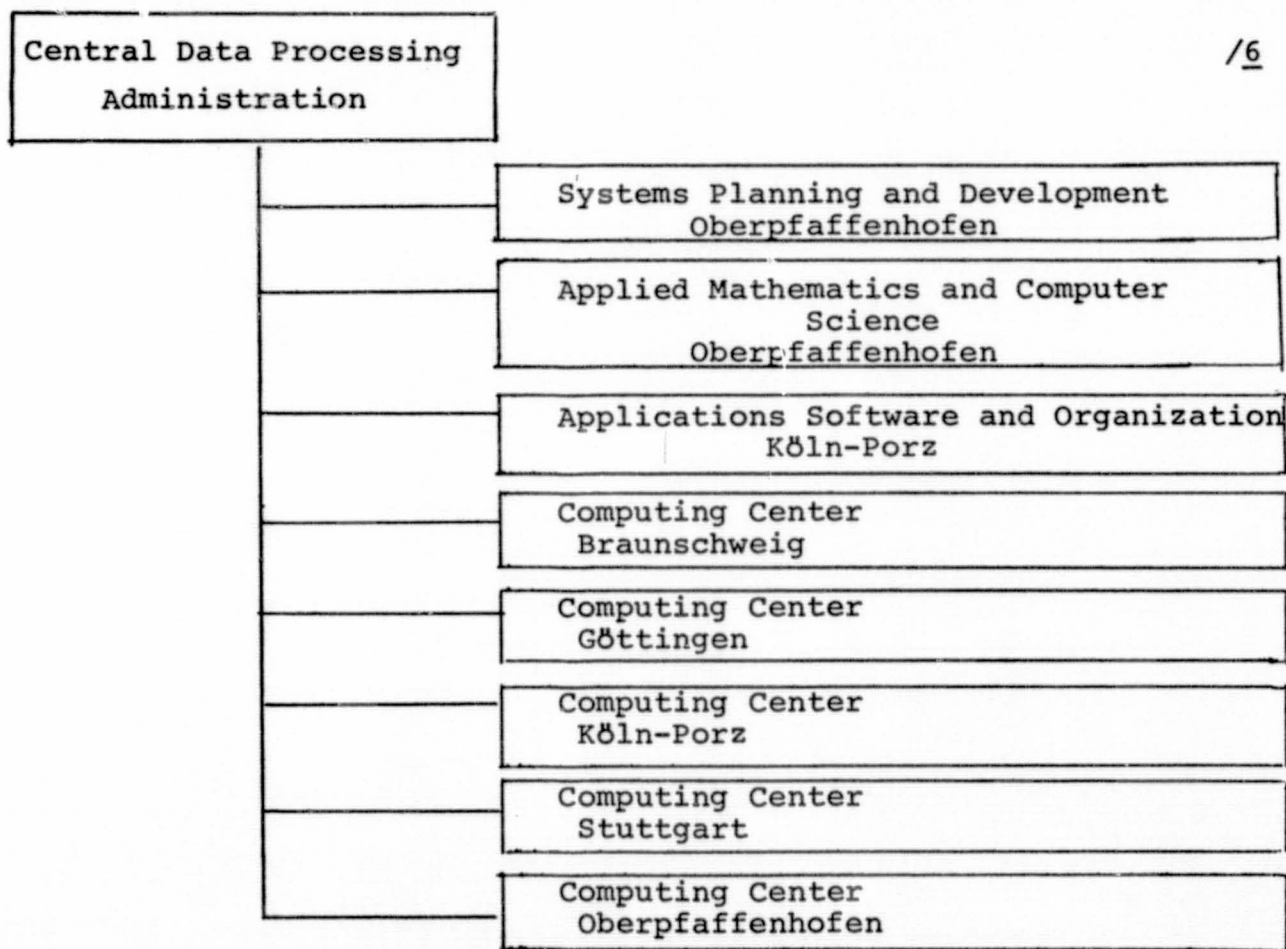


Fig. 1. Organizational Plan of the Main Dept. for Central Data Processing.

In the years 1977-1981, it was possible to increase considerably /7 the efficiency of data-processing systems in the Dept. for Central

Data Processing. Such progress was due to an ever-improving relationship between cost and performance of hardware, whereby it was not necessary to increase the budget of the Main Dept. Another big advance was made toward uniformity of computing facilities when both Siemens and Amdahl began to offer IBM-compatible computer equipment. At the request of users, the Siemens BS2000 operating system in Braunschweig was replaced by the IBM MVS-system.

In 1981, the Main Computing Dept. presented the executive office with a budget projection of 11.5 million DM per year for the years 1981-1986; this figure was a good 2.5 million DM below the average annual budget of 14.0 million DM for data-processing equipment during the years 1976-1981. Included in this budget projection was a plan to replace the operating systems in all the local stations with the IBM MVS-system. In the meantime, due to a change in DFVLR funding, the Division of Scientific and Technical Operating Equipment (Data Processing) called for the submission of an amended budget proposal staying within an annual budget figure of 10.5 million DM. This budget cut, along with increased user demands, forced the division to seek a more economical solution. Such a solution was found in a plan calling for the utilization of different operating systems for interactive and batch-oriented tasks:

IBM - MVS

in the central dept. in Oberpfaffenhofen for tasks
calling for batch processing

IBM - VM

at the local sites for tasks requiring interactive
mode

Implementation of this plan commenced in 1982 in Köln-Porz. Oberpfaffenhofen was next, receiving the VM system in mid-1983. Stuttgart will be supplied with the VM system after the planned relocation to a new computing center has been completed. In the cases of Braunschweig and Göttingen, the MVS system must remain available at the sites along with the VM system for a time, so that compatibility with programs that have been running there for some time can be ensured. Further measures will be necessary as well. Thus, it is not possible at this point to set up a precise timetable for these sites.

Providing the various sites with uniform equipment and systems, however, was only the means by which the actual task of the Dept. for Central Data Processing could be accomplished--namely, to make it possible for DFVLR employees to gain access to the capabilities of every data-processing system from any given site. Creating the DFVLR /8 Computer Network was thus a key focus of Main Dept. efforts in the years 1977-1981.

Linking the general-purpose computers in the DFVLR research centers to one another in a network, however, was hindered considerably by two peripheral circumstances:

1. The general-purpose computers at the local sites were manufactured by different firms and could be operated only under different operating systems. The MVS and BS 2000 operating systems, though, could not be easily incorporated into one common network.
2. At the outset of this work in 1977, none of the manufacturer-developed networks (neither TRANSDATA by Siemens nor SNA by IBM) had been employed in routine operation, at least in Germany. The DFVLR was thus de facto in the position of being the pilot user, though this was not explicitly stated.

The first step, then, involved uniting the computers using IBM operating systems into a network under IBM Systems Network Architecture (SNA). Creation of this linkage alone required an expenditure of a good ten man-years, since a very complex software system had to be mastered and implemented by the appropriate staff shortly after release of the system by the manufacturer.

The second step in creating the linkage was to join together the Siemens systems into a Siemens TRANSDATA network and, parallel to this, to devise the connection between the IBM and Siemens systems. The bridging of the IBM and Siemens systems was first made feasible with the aid of the gateway technology developed in the SNATCH project (see Section 8.1), which technology permits one to connect closed manufacturer networks.

The DFVLR Computer Network in existence today permits access to /10 all systems at will (including the CRAY-1S)² from any given DFVLR site. In addition, accessing of SNA from DECNET* will soon be possible--a result of efforts in the DICNET project (see 8.2.1), conducted in collaboration with the Indian Space Research Organization (ISRO). Then it will be possible as well for the process-control computers of the institutes, which are linked to the local process-control computers of the WT-DV, to access DFVLR general-purpose computers via the SNA network.

Figure 2 shows the structure of the DFVLR Computer Network, the geographic distribution of the Main Dept. over the various DFVLR research centers, and the outfitting of equipment at the various sites.

² Access to the VM system in Köln-Porz from the other sites has not been made possible to date, since there has been no demand for this.

*Translator's Note: Spelling rendered as in original.

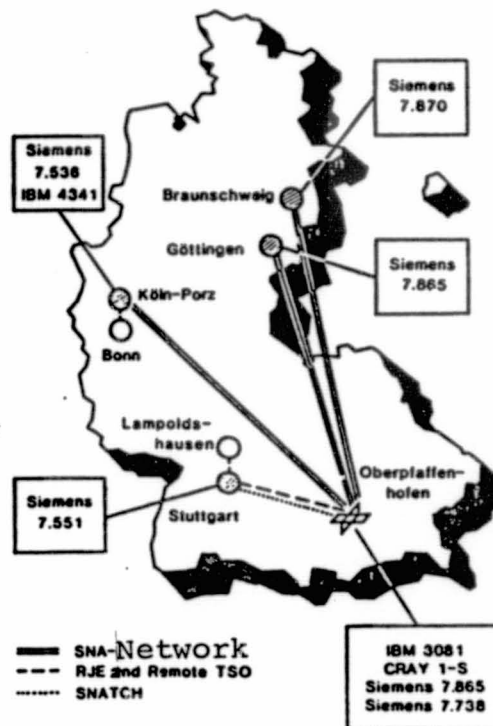


Fig. 2. Geographic Structure of DFVLR Dept. for Central Data Processing.

2. Responsibilities of the Dept. for Central Data Processing

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The fact that the various sections of the Dept. for Central Data Processing are spread over a number of locations that are situated at great distances from each other (see Fig. 2) is a direct consequence of the decentralized geographic structure of the DFVLR, which maintains research centers in five different locations in the Federal Republic of Germany. The task of the Dept. for Central Data Processing is to provide these research centers (including smaller branch offices) with a wide spectrum of services whenever central handling of data-processing tasks associated with DFVLR research and projects is called for. Services provided to the various sites range from purely routine operation of equipment, maintenance of the systems, and instruction and advising of users, to intensive support of users confronting a multitude of mathematical and data-processing problems of a technical nature.

The legitimate right of users to expect help and support with all important data-processing questions requires, however, that the Dept. for Central Data Processing do more than passively await the requests of users at the various sites. To meet the needs of users in the fullest sense, the Dept. for Central Data Processing would have to be active in following and assessing advances in data processing, making a continual effort to keep up with the rapid pace of new developments in hardware, software, and methodology.

To attempt to do this in all areas of data processing is utterly out of the question. Even if the Dept. for Central Data Processing were to restrict itself to keeping abreast of only those areas relevant to the work of the DFVLR, its financial and staff resources would be burdened well beyond capacity. The department must therefore selectively choose specific points of focus when attempting to review work relating to new systems and procedures, concentrating on just a few concerns of particular significance for the current and future work of the DFVLR. The points of concentration selected constitute tasks that cut across a number of areas--tasks with which staff from several sites and divisions (working usually under the direction of one of the division leaders) are involved. A full discussion of this is contained in Sections 8-14.

The following groups of key phrases provide an overview of Main /12 Dept. functions relating both to the individual sites as well as to a wider sphere.

Tasks Pertaining to Individual Sites

- Operating general-purpose and local process-control computers
- Advising the institutes and facilities on procurement of data-processing equipment and systems
- Coordinating purchase of data-processing systems within the DFVLR
- Maintaining and adapting systems and network components vital to operations
- Providing users with advice, support, and instruction
- Maintaining and adapting program libraries and user systems

Areas of Involvement Extending Beyond Individual Sites

- Computer networks and communication
- Process control
- Text processing
- Computer-generated graphics
- High-speed computers
- Administrative Data Processing
- Training of assistants in mathematical and technical realms

3. Goals and Future Endeavors of the Dept. for Central Data Processing

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It is impossible today for any DFVLR facility to function economically and efficiently without availing itself of the modes of thought, methods, and systems (hard- and software) afforded by data

processing.

The above assertion has been true for the scientific endeavors of the DFVLR for a long time. In recent years, however, data processing has become increasingly indispensable in areas where it had formerly played a minor role--above all in the administration and in those sections of the research institutes and stations that perform administrative tasks.

Given this situation, it is understandable that the various DFVLR stations strive to exert independent control over such a vital tool--one that determines both the content and scope of project results. Equally understandable, however, is the fact that uneconomical modes of work, isolated solutions, unnecessary duplication of efforts, and costly individual ventures would result were the DFVLR to give free rein to such wishes.

The only possible solution for the DFVLR is to effect a compromise between the two extremes, namely full autonomy of the institutes (decentralized data processing) and concentration of data processing in one location (centralized data processing). Such a compromise calls for allocating tasks between centralized and decentralized systems on the basis of the more cost-effective approach, and to combine both systems into a single one (integrated data processing) in such a way that the work of one system serves to complement and support the work of the other.

The technical prerequisite for coordinating the work of centralized and decentralized data processing is the existence of local and system-wide networks. Additional criteria (besides cost) for the allocation of tasks are the availability and reliability of the systems and components, their relative user-friendliness, and their adaptability to changing needs.

Thus, the balance struck between centralized and decentralized /14 data processing is determined both by the demands of users and by the technical options open, as well as by the cost of implementing these options. As a consequence, the balance between centralized and decentralized data processing will shift back and forth from year to year.

3.1 Goals of the Main Dept. for Central Data Processing

The Main Dept. for Central Data Processing plays a decisive role in ensuring the coordinated action of centralized and decentralized data processing. The department is, of course, responsible for the smooth operation of all centrally-installed systems and equipment. At the same time, however, it is charged as well with the planning and development of all data processing in the DFVLR. To illustrate concretely the concept of planning: In its role as planner, the department must find a compromise (i.e., acceptable course) between wishes (user demands) and reality (technological and economic options and constraints). In its role as developer (trail blazer), the dept.

must effect this compromise; it must make available to users modern procedures and systems in a form ready for use (working in the forefront); and, finally, it must introduce users to the new direction ("missionary work") and acquaint them with it (instruction).

With the preceding serving as background, the goals of the Main Dept. for Central Data Processing are:

- to provide cost-effective service for all users (scientists, administration, technical operations, outside clients, etc.) with available equipment, systems, and methods (e.g., general-purpose computers, high-speed computers, process-control computers, work-station systems, program libraries, programming methods) and to provide advice concerning their use (Operations).
- to keep equipment, systems, and methods on state-of-the-art level (Performance).
- to assure availability and reliability of the equipment and ^{/15} systems in accord with demands in the DFVLR--taking into account as well requirements for safeguarding data and confidentiality.
- to maintain the flexibility and adaptability of the equipment, systems, and methods, such that these can accommodate changes (e.g., new technological developments, organizational changes, new demands on part of users), without adversely affecting service quality and reliability.
- to seek out and tap new data-processing systems and techniques that can be utilized for centralized or decentralized DFVLR tasks, thereby improving the capabilities and cost-effectiveness of data processing.
- to engage in programs and projects for the purpose of acquiring expertise and experience with systems and, in so doing, to enhance the reputation of the DFVLR.
- and, finally, to take on outside contracts as a means of covering the DFVLR budget, whenever such arrangements will not disrupt operations for DFVLR users.

These goals create a framework in which both short-range work and longer-term endeavors of the Main Dept. have a place, and in which cooperative action between centralized and decentralized data processing is apparent as well. Accordingly, the task of the Main Dept. is:

- to develop an overall plan for procurement and implementation of data-processing systems (hard- and software) in the DFVLR, paying particular attention to the issue of centralization vs. decentralization.
- to integrate all areas of data processing into this plan.

- to create a uniform technical foundation for the cooperative /16
action between centralized and decentralized data processing
through uniform local and system-wide networks.
- to analyze, test, and prepare new data-processing methods
and systems prior to their introduction into general operation.

3.2 Tasks for the Immediate Future

The following overview outlines the most important tasks facing the Dept. for Central Data Processing in the near future (the next two years), as well as the relationship of these tasks to more general concerns.

| TASK | GENERAL AREA OF CONCERN |
|---|--|
| Introduction of the VM/370 operating system to all local computers (general-purpose computers). | Improvement of efficiency and response-time behavior in interactive mode. |
| Expansion and improvement of the text-processing system, esp. for scientific texts (writing of equations). | Non-numerical data processing (graphics, text processing, data management and organization) as constituent of office automation. |
| Improvement of local process-control computers, above all through efficient links with general-purpose computers (Hyperchannel, LAN). | Improvement of measurement-data processing as well as interpretation and control of test results. |
| Introduction of parallel-processing methods. | Employment and cost-effective utilization of very high-speed computers for certain fields of application. |
| Introduction of standard software for administrative data processing. | Standardization of hard- and /17 software; automation of administrative procedures as part of office automation. |

These plans for the near future already reveal the desire of the Dept. for Central Data Processing to augment services for all DFVLR users. Available funds and personnel will determine in large part the extent to which such plans can be realized as well as the time framework within which they can be executed. (See also Section 4.)

3.3 Longer-Term Tasks

The longer-term tasks are concretely formulated plans derived from the general goals set forth at the beginning of the chapter. The Dept. for Central Data Processing, working in collaboration with other DFVLR facilities, is responsible for these areas of endeavor.

Computer Networks and Process Automation

Belonging to this area of endeavor are the following:

- Evaluation of process data
- Management of measurement- and process-data
- Construction and upgrading of local networks
- Satellite communication as possible means of wide-band data transmission over large distances

The "Virtual Work-Station System" (The "Virtual Personal Computer")

Included in this area of endeavor are:

/18

- Investigation and testing of personal computers available on the market
- Introduction of operating systems lending themselves to general use (UNIX)
- And, together with this, upgrading and expansion of capabilities in interactive mode
- Enhancement of network efficiency and user-friendliness

Office Automation and Management of Data Processing

Belonging to this area of endeavor are:

- Text processing and text management
- Computer-generated graphics
- Office automation
- Data management
- Documentation and information systems
- Computer-supported planning and monitoring of projects

As was the case for short-term tasks of the DFVLR, the extent to which these longer-range tasks can be realized hinges on the budget and personnel available to the DFVLR in the next five years. As stated at the outset, optimal utilization of all resources is the primary goal of the Dept. for Central Data Processing.

4. Machines, Equipment Resources, and Personnel of the Dept. for Central Data Processing /19

4.1 Organization of Personnel

TABLE 3. DISTRIBUTION OF DFVLR EMPLOYEES ACCORDING TO AREAS OF SPECIALIZATION

| | Categ. 1 | Categ. 2 | Categ. 3 | MTB | Total | Con. |
|---|-------------|-------------|-------------|-----|--------|------|
| Administration, Secretarial Offices, Infrastructure | 7.3 | 1.5 | 8.45 | | 17.25 | |
| Coordination of Data Processing | 2.0 | | | | 2.0 | |
| Operation of General-Purpose Computers | | 4.6 | 21.0 | | 25.6 | |
| Maintenance, Adaptation, and Devel. of Operating and User Systems | 8.9 | 6.6 | | | 15.5 | |
| Advising, Support, and Instruction of Users | 11.6 | 9.8 | 1.0 | | 22.4 | |
| Computer Networks and Communication | 8.0 | 3.5 | | 1.0 | 12.5 | 8.0 |
| Process Control | 4.4 | 5.5 | | | 9.9 | |
| Text Processing | 3.1 | 1.8 | 0.3 | | 5.2 | |
| Devel. and Putting into Operation of Work-Station Systems | 0.9 | 0.5 | | | 1.4 | |
| Computer-Generated Graphics | 0.7 | 4.0 | | | 4.7 | |
| High-Speed Computers | 4.5 | | | | 4.5 | |
| Administrative Data Processing | 3.0 | 8.1 | 5.5 | | 16.6 | 3.0 |
| Training of Assts. in Technical/Mathematical Realms | 1.6 | 0.1 | | | 1.7 | |
| Total No. Employees | 56.0 | 46.0 | 36.25 | 1.0 | 139.25 | 11.0 |
| No. Under Term Contracts | 10.0 | 7.0 | 2.0 | | 19.0 | |

The categories in Table 3 correspond to the following wage classifications [German];

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Categ. 1 Salary Groups SV - IIa BAT [Wage Agreement for
Federal Employees]

Categ. 1 Salary Groups IIaT - Va BAT
[Translator's Note: Orig. reads "Kat. 1"; should be Categ. 2?)

Categ. 1 Salary Groups Vb - X BAT
[Translator's Note: Orig. reads "Kat. 1"; should be Categ. 3?)

Con. Contractors (additional)

[MTB = Manteltarif Vertrag für Arbeiter des Bundes:
Collective Wage Agreement for Federal Workers]

Excluded in the Main Department's allocation scheme are 27 trainees at the Braunschweig, Göttingen, and Oberpfaffen sites.

4.2 Evolution of the Budget, 1976-1983

In 1976, general-purpose computers worth 50 million DM (new) were installed in the computing centers. With a write-off over five years, that amounts to an annual debit of 12 million DM. After the new computer-system plan had been adopted in 1976, purchase agreements were signed for the Amdahl 470 V/6 in Oberpfaffenhofen and the IBM/370-158 in Göttingen. The three Siemens units of the 7000 series were rented.

Figures 3 and 4 show the evolution of the budget of the Dept. for Central Data Processing from 1976-1983, broken down both into expenditure categories and specialized equipment. The figures clearly show that expenditures for the general-purpose computers have steadily diminished since 1979, from an average figure of 14 million DM in the years 1976-1983 to 10.5 million DM from 1982 on. Concurrently, the efficiency of the data-processing systems was increased considerably. (See Section 5.) Falling expenditures coupled with enhanced performance is synonymous with increased cost-effectiveness of general-purpose computers in the DFVLR. Several factors were responsible for this auspicious trend:

- The relationship between the cost and performance of computer equipment, esp. of hardware, has improved dramatically within the last few years.
- The DFVLR had success in working out favorable contract terms (e.g., leasing instead of rental).
- A well thought-out policy on the part of the DFVLR with respect to manufacturers [i.e., purchase of IBM-compatible systems only, though these might emanate from several different manufacturers] led, in the final analysis, to acquisition of hardware at more favorable prices.

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- Increasing knowledge and experience of staff in the Dept. for Central Data Processing led to better utilization of the systems.

Although the budget today is 20% smaller than in the years 1976-1981, the Dept. for Central Data Processing currently offers its users (to take just two examples) a total of 450 terminals as opposed to 100, and a performance level of 25 MIPS as opposed to 8 MIPS. Similarly, it was possible to improve other components of the data-processing systems (main memory, background storage, throughput, etc.). In such a way, it proved possible to increase and improve dramatically both the scope and the quality of services.

In the future, however, cost-effectiveness will be influenced only minimally by the last three factors cited in the preceding list. Only if new, even more favorably priced data-processing systems appear on the market will it be possible in the future to expand services further at the present level of expenditure.

That means, however, that user demands in the data-processing area (and such demands will continue to grow in the future, as they have in the past) can be absorbed only through an improved relationship between cost and performance, if the budget for data-processing is to remain constant. It is to be expected that users will not be able to limit their demands to this degree.

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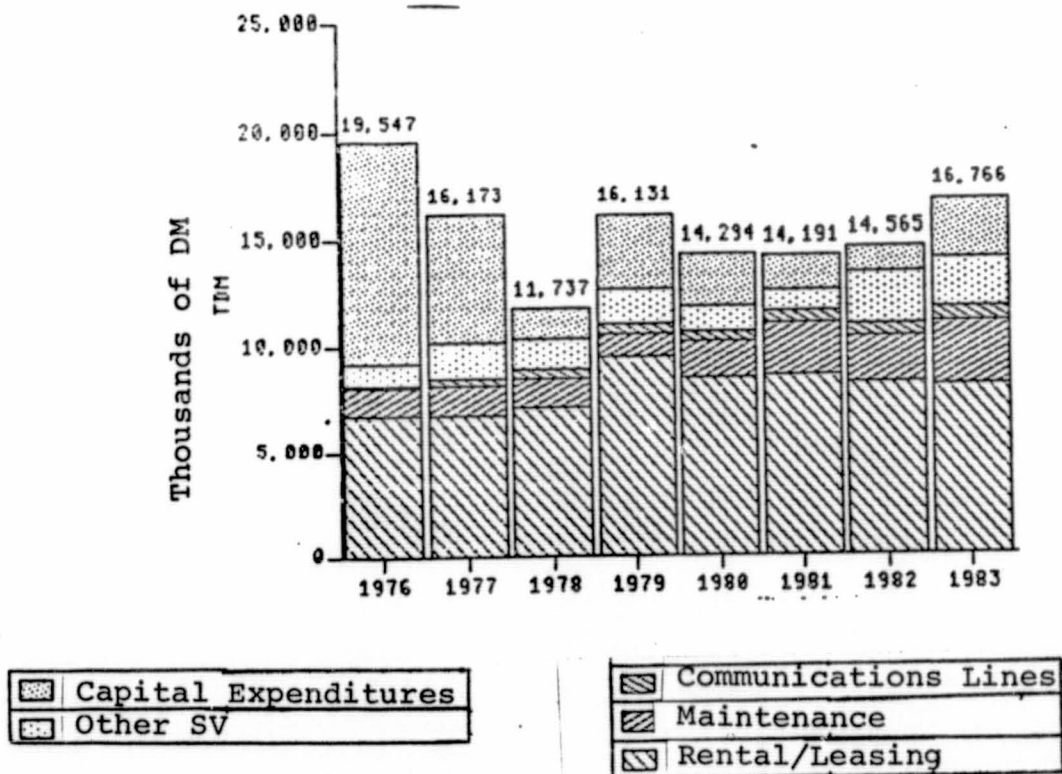


Fig. 3.

Basic Financing of Equipment Resources and Investment Capital, 1976-83.

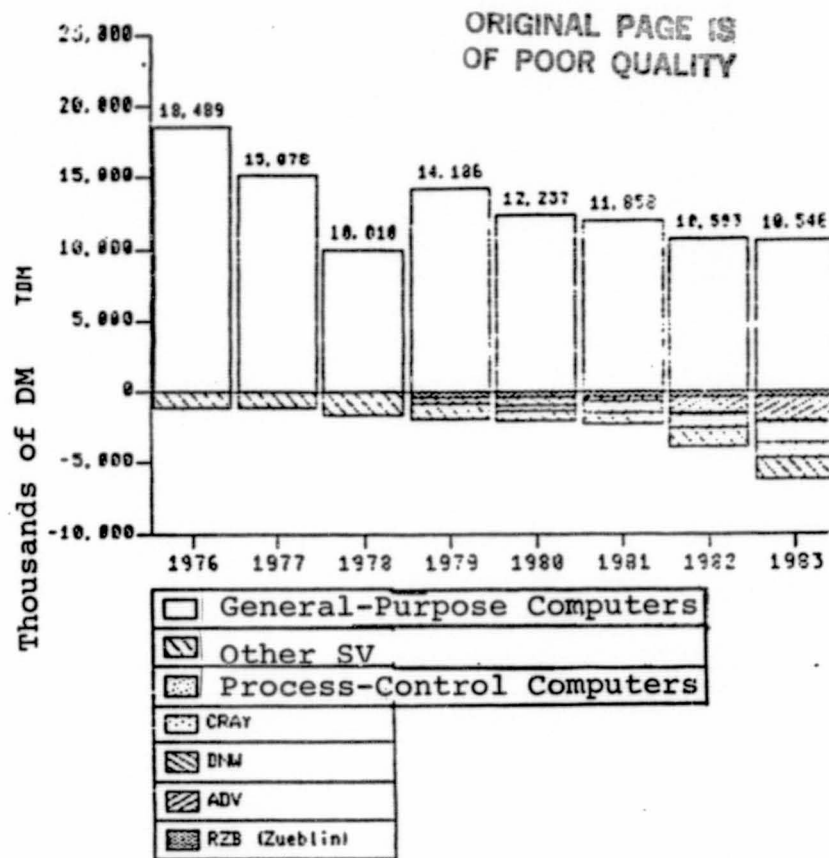


Fig. 4. Juxtaposition of Expenditures for General-Purpose Computers and Specialized Devices.

4.3 Equipment and Systems

An overview of the equipment and systems installed in the Main Dept. for Central Data Processing on 7/31/83 is provided in Appendix B.

PART II: Tasks Pertaining to the Individual Sites

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5. Operation of Equipment and Systems

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It is the task of the five computing centers of the Main Dept. for Central Data Processing to make available to users at all times the general-purpose computers (local computers) and the local process-control computers necessary for their work, including the networks by means of which these data-processing systems are linked to each other, and to ensure the proper functioning of these resources. Included in operations, therefore, are:

- Operation and maintenance of the general-purpose and local process-control computers
- Operation and maintenance of the operating systems for the general-purpose and local process-control computers
- Maintenance of communications lines and connections of the DFVLR Computer Network and the local data-processing networks in the five research centers

These tasks require that the Dept. for Central Data Processing have significantly more personnel than is typical for a computing center, since in this case the computer equipment is spread over five locations throughout Germany. Moreover, the computers are compatible with each other only under certain conditions, as they were produced by different manufacturers. Despite the fact that most of the equipment employs the same operating system, systems maintenance in the Dept. for Central Data Processing still requires that this one system be tended and maintained in different locations and in different versions for differing equipment configurations--tended and maintained in such a way that users experience little change when switching from one system to another.

The integration of mutually compatible equipment into a DFVLR computer network affords users many advantages: the opportunity to draw on the capabilities of any computer in the network from any location (interconnection of functions), direct access to the computing resources of the superlarge CRAY 1/S computer, filing of large data files centrally on the mass memory, forwarding of data to any desired point in the network, etc. The operation and maintenance of communications lines and connections for this computer network do nevertheless constitute an added expenditure for the Dept. for Central Data Processing.

5.1 Performance Statistics

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Table 4 gives an overview of the performance statistics (workload, reliability, etc.) for the operation of local process-control computers through the end of 1982; these values were obtained using the GUIDE system. One should note that the values for CPU time do not include time spent for housekeeping functions for the operating systems--in normal operations a good 25% of the values cited (in interactively- /29 oriented systems up to 40%). The following provides an explanation of some of the terms appearing in the table:

Production Time

Calendar time deducted for

- Time Turned Off
- Planned Down Time
- Unplanned Down Time
- Idle Time

Idle Time

CPU in "Manual State" (stopped)

CPU Times

CPU times are those times obtained via SMF (System Measurement Facility) and charged directly to users with the aid of "Accounting". That is the TCB- (Task Control Block) and SRB- (System Request Block) times.

Computing-Center Availability

(Time Turned On - Unplanned Down Time) : Time Turned On

Unit measuring deviation from planned user operation, whereby unplanned down times are taken into account.

System Availability

(Time Turned On - Planned Down Time - Unplanned Down Time) : Time Turned On

Unit measuring the availability of the data-processing system, whereby both planned and unplanned down times are taken into account.

No-Failure Interval

Production Time : (unplanned IPL's + 1)

Comparable to "Mean Time Between Failures" (MTBF).

TABLE 4. 1982 PERFORMANCE STATISTICS,
MAIN DEPT. FOR CENTRAL DATA PROCESSING

Performance
Stats., 1982

| Braun | Gö | Köln | Stutt | Oberpf |
|-------|-------|------|-------|------------|
| 7.870 | 7.865 | 4341 | 7.536 | 7.551 |
| | | | | 470/ 7.865 |
| | | | | 3081 |

HOLDING TIMES
(hrs.)

Time Turned Off

| | | | | | | |
|------|------|------|------|------|-----|-----|
| 2855 | 1874 | 1028 | 5670 | 4121 | 205 | 563 |
|------|------|------|------|------|-----|-----|

Time Turned On

| | | | | | | |
|------|------|------|------|------|------|------|
| 5905 | 6886 | 2645 | 3106 | 4619 | 8587 | 1597 |
|------|------|------|------|------|------|------|

Of which:

Repair/Mainten.

| | | | | | | |
|-----|-----|-----|-----|--|-----|----|
| 385 | 165 | 132 | 268 | | 409 | 61 |
|-----|-----|-----|-----|--|-----|----|

Down Time

| | | | | | | |
|-----|----|----|----|-----|-----|---|
| 165 | 33 | 14 | 35 | 134 | 167 | 3 |
|-----|----|----|----|-----|-----|---|

Idle Time

| | | | | | | |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
|---|---|---|---|---|---|---|

Production Time

| | | | | | | |
|------|------|------|------|------|------|------|
| 5355 | 6687 | 2499 | 2804 | 4485 | 8011 | 1534 |
|------|------|------|------|------|------|------|

CPU WORKLOAD
(hrs.)

Batch

| | | | | | | |
|------|------|---|-----|------|------|-----|
| 1587 | 2016 | 0 | 236 | 1378 | 3933 | 260 |
|------|------|---|-----|------|------|-----|

Interactive

| | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|
| 258 | 265 | 231 | 218 | 508 | 505 | 117 |
|-----|-----|-----|-----|-----|-----|-----|

Total

| | | | | | | |
|------|------|-----|-----|------|------|-----|
| 1845 | 2281 | 231 | 454 | 1886 | 4437 | 377 |
|------|------|-----|-----|------|------|-----|

% of Production Time

| | | | | | | |
|----|----|---|----|----|----|----|
| 34 | 34 | 9 | 16 | 42 | 55 | 25 |
|----|----|---|----|----|----|----|

PERFORMANCE /
THROUGHPUT

No. of Batch Jobs

| | | | | | | |
|--------|--------|---|-------|-------|--------|-------|
| 140420 | 110216 | 0 | 18567 | 71628 | 274460 | 28443 |
|--------|--------|---|-------|-------|--------|-------|

No. of Interactive
Sessions

| | | | | | | |
|-------|-------|-------|-------|--------|--------|-------|
| 76878 | 61306 | 16687 | 31655 | 134546 | 159372 | 23067 |
|-------|-------|-------|-------|--------|--------|-------|

RELIABILITY

Comp. Ctr.
Availability

| | | | | | | |
|-------|-------|-------|-------|-------|-------|-------|
| 97.2% | 99.5% | 99.5% | 98.9% | 97.1% | 98.1% | 99.8% |
|-------|-------|-------|-------|-------|-------|-------|

System
Availability

| | | | | | | |
|-------|-------|-------|-------|-------|-------|--|
| 90.7% | 97.1% | 94.5% | 90.3% | 93.3% | 96.0% | |
|-------|-------|-------|-------|-------|-------|--|

No-Failure
Interval (hrs.)

| | | | | | | |
|-------|-------|-------|-------|-------|-------|------|
| 103.0 | 230.6 | 208.2 | 103.8 | 133.5 | 306.7 | 72.3 |
|-------|-------|-------|-------|-------|-------|------|

Detailed descriptions of the activities of the various computing centers, their services and computer equipment, can be found in the following documents:

- "Zusammenstellung der DV-Systeme und Infrastruktur der Hauptabteilung Zentrale Datenverarbeitung" [Compilation of the Data-Processing Systems and Infrastructure of the Main Dept. for Central Data Processing], with annual update /30
- Jahresberichte der Zentralen Datenverarbeitung [Annual Reports of the Dept. for Central Data Processing]
- Wissenschaftlich-technischer Bericht des Bereichs WT [Scientific and Technical Report of the Division of Scientific and Technical Operating Equipment]
- Jährliche DFVLR Ergebnisberichte [Annual DFVLR Reports on Results]

In the report of Professors Griese and Richter (Summer 1983), some suggestions were made on ways to improve availability and response time. Data on the availability of systems should be recorded in all computing centers according to uniform guidelines, then forwarded and evaluated. Network availability should be monitored by machine and protocolled. In order for it to be possible to evaluate the Ist data, performance goals for availability must be on hand, classified according to system components.

Performance goals are also needed for response-time behavior of the systems. These times can be measured only with real-time monitors, which must be installed at the user sites.

The consultants also predict further improvements in availability if the block times for maintenance, data protection, etc., were coordinated in all the centers.

5.2 Braunschweig Computing Center

Prompted by the increasingly comprehensive and complex work of Braunschweig users in many areas--above all in real-time simulation and process control--the DFVLR has continually expanded the capabilities of the computing center since 1977. This expansion was achieved through the following measures:

1. Hardware

Local Computers

- Increase of processor performance from 500 KOPS to 3 MOPS
- Enlargement of main memory from 1 MB to 8 MB
- Enlargement of magnetic-disk memory from 550 MB to 5,706 MB /31
- Increase in number of alpha-numeric display units from 12 to 67, and in number of graphics display units from 1 to 8.

Simulation Computer

Installation of AD10 Parallel Computer

Local Process-Control Computer

Installation of VAX 11/750 Process-Control Computer

2. Software

Local Computer

- Conversion to OS/VS2 (MVS)
- Installation of software for
 - Numerical Mathematics (IMSL, EISPACK, etc.)
 - Structural-Mechanics Tasks (ASKA)
 - Computer-Generated Graphics (GINO-F)
 - Text Processing (DOCULITY, GML)

Local Process-Control Computer

- Software support for RSX and RT11 systems
- MININET network software
- DATS11 software for processing numerical and graphic measurement data

While the expansion of hardware served primarily to improve turn-around times in batch processing as well as to improve response times in interactive mode and the long-term preservation of data, the augmentation of software resources provided users with new possibilities for utilizing the data-processing equipment in place. Foremost among these:

- Development of applications in interactive mode
- Compatibility with central data-processing systems in Oberpfaffenhofen
- Easy access to the central data-processing systems via SNA /32 interconnection
- Creation of connection between local process-control computers

For the most part, Braunschweig users began to make full use of newly introduced data-processing services after just a short time. For these users, the computer facilities represent a vital resource promoting better and more economical resolution of research tasks.

The following overview sketches the development of the Braunschweig computing center in past years:

1976

- Installation of a Siemens 7.755-J with the BS2000 operating system, coupled with:
 - ten 4581 disk drives with 55 MB apiece
 - 10 alpha-numeric display units
 - 1 graphics display unit
 - 1 batch terminal, 2 alpha-numeric display units in the Kralenriede branch
- Connection of a batch terminal to the IBM 370/158 in Göttingen

1977

- Exchange of the peripheral disk devices for:
 - 4 disk drives up to 72 MB apiece
 - 6 disk drives up to 144 MB apiece
- Connection of the batch terminal, formerly connected in Göttingen, to the Amdahl 470/V6 in Oberpfaffenhofen
- Installation of 4 IBM display units, with connection to Oberpfaffenhofen
- Installation of a graphics display unit in the Institute for Structural Mechanics
- Commencement of construction of new computing-center site /33

1978

- Expansion of main memory by 512 KB
- Installation of a DFÜ processor with 2 alpha-numeric display units
- Installation of 4 additional IBM display units
- Installation of 3 additional graphics display units, one with hardcopy in computing center

1979

- Replacement of central processing unit by a Siemens 7.760 with 1.5 MB main memory
- Replacement of 3 magnetic tape units by 3 devices operating bimodally with 1600/6250 bpi
- Replacement of:
 - 4 disk drives up to 72 MB apiece
 - 2 disk drives up to 144 MB apieceby
 - 4 disk drives with 420 MB apiece

- Replacement of 10 display units, installation of 5 medium-speed printers to provide hardcopy in the institutes

1980

- Relocation to the new computing-center facility
- Installation of a Siemens 7.870 with the OS/VS2 MVS operating system
- Installation of an electrostatic plotter manufactured by the Benson firm

1981

- Disassembly of the Siemens 7.760
- Expansion of main memory to 8 MB
- Installation of a 3777 batch station with card-punching unit
- Installation of 6 DSPRINT printers
- Transfer of the "hybrid computing" group to the Institut für /34 Flugmechanik
- Installation of a VAX 11/750 with VMS operating system as local process-control computer

1982

- Incorporation of High Speed Arithmetic
- Reduction of cycle time from 70 μ my.sec to 59 μ my.sec
- Installation of 29 terminals
- Linking of 12 process-control computers to the VAX 11/750

5.3 Göttingen Computing Center

Increasing user demands for

- interactive mode
- computer performance
- disk space

could be fulfilled very satisfactorily by continual expansion of the local computer during the last six years. The following comparison serves to illustrate this development:

| | 1977 | 1983 |
|------------|-----------|------------|
| VDTs | 14 | 85 |
| Disk Space | 800 MByte | 3340 MByte |

| | 1977 | 1983 |
|-------------|-----------|----------|
| Main Memory | 1.5 MByte | 8 MByte |
| CPU | 0.9 MIPS | 1.9 MIPS |

The doubling of computing speed achieved by replacement of the IBM 370/158 (in place since 1972) with a Siemens 7865 in 1981 had only a temporary effect on the workload of the computer, since the higher performance was absorbed by the users within a short period.

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Services available to users of the local computer were qualitatively enhanced by switching from the SVS operating system to the MVS in 1979 (leading to increased operational dependability), as well as by implementing the SPF menu-directed user guide system in the same year, and by facilitating access to the other DFVLR computing centers via introduction of the SNA interconnection in 1981. To ensure good response times in interactive mode over the long term, initial studies on the installation of VM/CMS commenced in the Göttingen research center (FZ) at the close of 1982.

A noteworthy development in the area of process-control computers paralleled the expansion of the local computer. Realization of plans for a local process-control computer began in 1977 with installation of the PDP 11/34 local process-control computer in the computing center. The necessity of supporting software development for the German-Dutch Wind Tunnel prompted use of DECnet network components.

The following represent developmental stages leading to the local process-control computer system in operation today:

- Installation in 1980 of a rapid A/D transducer with a PDP 11/34 as collection system
- Installation in 1982 of an efficient VAX 11/780 local process-control computer
- Completion of the coupling of the process-control computer and large computer via the IBM/7 in Spring 1982

With the expansion of the local process-control computer system and the increasing cross-linkage via DECnet of the test-bay computers at the Göttingen FZ serving as a foundation, it will be possible at the close of 1983 to replace on-line collection of wind-tunnel measurement data carried on since 1972 via a special coupling to the local computer by a more flexible process-control computer approach, one reflecting state-of-the-art technology.

A detailed sketch of the evolution of the Göttingen computing center follows:

- Equipping of the local IBM 370/158 computer: 1.5 MByte general storage, 8 IBM 3333/3330 disk drives, SVS operating system
- RJE [Remote Job Entry] DATA 100 terminal linked via private line to the Amdahl in Oberpfaffenhofen
- Local PDP 11/34 process-control computer installed together with DECnet Version 1

1978

- Expansion of the main memory of local computer by 2 MBytes
- Redesigning of IBM 3420-4 tape units for use on Model 8 (6250 Bpi)

1979

- Conversion to MVS operating system, achieving substantial compatibility with the central large computer in Oberpfaffenhofen
- Installation of an IBM 3850 disk control unit with 6 IBM 3350 disk drives
- Installation of an additional RJE terminal in the Göttingen FZ
- Installation of one PDP 11/60 and one PDP 11/34 in the computing center and connection to DECnet for software development work relating to German-Dutch Wind Tunnel
- Development and installation of a coupling between the process-control computer and large computer via the IBM 2701

1980

- Expansion of air-conditioning system
- Second private line to Oberpfaffenhofen
- IBM 6670 laser printer installed for text output
- Installation of a rapid A/D transducer with a PDP 11/34 as collection system for the local process-control computer
- Delivery of the Vektor General 3-D graphics system to users
- Installation of a PDP 11/44 as replacement for the PDP 11/60 and 11/34, which were transferred to the German-Dutch Wind Tunnel Project

1981

- Replacement of the IBM 370/158 by a Siemens 7.865 with 6 MBytes and doubled computing efficiency

- Disassembly of the IBM 2305 drum storage (transferred to Oberpfaffenhofen)
- Expansion of the main memory by 2 MBytes
- SNA Cross-Domain connection to Oberpfaffenhofen and Braunschweig

1982

- Replacement of the IBM disk drives and control units by a Siemens 3860 disk control unit and 10 Siemens 3843 disk drives
- Replacement of tape units by Siemens 3859/3850
- Enlargement of disk capacity by acquisition of Siemens 3846 double tape drive
- Installation of an electrostatic printer-plotter manufactured by the Benson firm
- Conversion from TCAM interactive access method to VTAM
- Commencement of study investigating possibility of introducing VM operating system into the Göttingen FZ (Research Center)
- Installation of an efficient VAX 11/780 local process-control computer under VMS
- Release to users of the process-control computer - large computer coupling via IBM/7

5.4 Köln Computing Center

In the case of the Köln computing center, the needs of DFVLR administration were taken into account from the outset, along with technical and scientific problems. Administrative tasks take up one-third of computer capacity. In this respect, the Köln computing center is markedly different from the computing centers at the other sites.

When the Main Computing Dept. was established in 1976, a TR 440 /38 computer manufactured by AEG Telefunken was installed in the Köln-Porz computing center, which operated in a batch mode using the BS3 operating system. With the development of the DFVLR's new plan for computing services, this system was replaced in 1977 by a Siemens 7.755 computer under the BS2000 operating system, which allowed users for the first time to perform their work on the local computer in interactive mode.

For administrative purposes, however, this change necessitated considerable adjustments (see 13) due to incompatibility of the two systems. Moreover, the TR 440 had to continue to operate in parallel until 1978, when conversion of administrative software was complete.

With installation of a DATA 100 Remote Job Entry Station and the first of the IBM display units in the same year, users in Köln gained access to the central large computer in Oberpfaffenhofen in both

interactive and remote batch-processing modes.

The incompatibility of the systems available to users--the MVS system in Oberpfaffenhofen and the BS2000 system in Köln-Porz--and the drawbacks of this incompatibility motivated the local Köln-Porz Committee on Data Processing to press for uniformity and an IBM-compatible computer for Köln-Porz (medium-term). This conversion was effected in 1982. Köln-Porz received an IBM 4341 running under VM/CMS as its new local computer and was thereupon fully incorporated into the DFVLR Computer Network for the first time via SNA. The predecessor of the IBM 4341, a Siemens 7.536, will continue to operate in parallel for administrative batch-processing tasks until 1984. Installation of a second IBM-compatible computer is planned for 1983, on which all administrative tasks will be run under MVS. Thus, even the administration is moving away from pure batch-processing toward on-line input on the part of senior clerks.

In 1980, creation of the local process-control computer network commenced with a PDP 11/60 as local process-control computer under RSX-11M and MININET network software.

The plan for the process-control computer system was quickly /39 accepted by the Köln experimentalists. In just a short time, the PDP 11/60 local process-control computer was being utilized at full capacity. A VAX 780 was procured as a second local process-control computer to handle additional jobs.

A detailed overview of developments in Köln-Porz follows.

1977

- Installation of a Siemens 7.755-J computer with 1 MB main memory, four 3455 (72 MB) disk drives, six 3465 (144 MB) disk drives, five 3554 magnetic tape units, one 7-track 442 magnetic tape unit, and eleven 8152 display units
- Installation of a DATA 100 Remote Job Entry Station and connection of ten IBM display units to the AMDAHL 470/V6 in Oberpfaffenhofen via a 9600-baud postal line

1978

- Expansion of background-store capacity of the Siemens local computer through acquisition of two 3465 disk drives
- Increase in number of SIEMENS 8152 display units by 11, raising total to 21
- Disassembly of the TR 440
- Replacement of the 3271/3277 IBM display units by 3276/3278 models

1979

- Expansion of main memory of Siemens 7.755 by 0.5 MB, raising it to 1 MB
- Replacement of the 7.755 by a 7.760 (twice as fast) with 2 MB main memory
- Installation of five 420 MB fixed storage disks (3470) in exchange for four 72 MB and four 144 MB moving-arm disks (3455, 3465)
- Replacement of the Siemens 8161/8151 display units by the 8160
- Addition of eight 8160 display units, bringing total to 29
- Exchange of three 3554 magnetic-tape units (800/1600 bpi) for three 3557 magnetic-tape units (1600/6250 bpi)
- Installation of the PDP 11/60 local process-control computer /40 with 248 KB main memory, two RMO3 moving-arm disk drives and one magnetic tape unit (800/1600 bpi)

1980

- Discarding of outdated peripheral devices and replacement of same with
 - new Benson on-line pen-plotter
 - off-line MDS 2501 printing station
- Increase in display units to
 - 31 Siemens 8160 models
 - 15 IBM 3278 models
- Installation of a second HFD line to Oberpfaffenhofen
- Conversion of rental agreement for Siemens 7.760 to more favorable agreement for a 7.551
- Creation of the local process-control computer network with MININET coupling of six process-control computers in the institutes

1981

- Installation of the IBM 3705 communications computer
- Putting uninterruptable electric power supply into service
- Putting DATA-SAAB 4101 controller with eleven 4110 display units into operation
- Putting IBM 3274 controller with twenty-five IBM 3278 display units into operation
- Conversion of rental agreement for Siemens 7.751 to more favorable agreement for a Siemens 7.536

- Installation of the second local process-control computer (VAX 780) with 0.5 MB main memory, one RMO3 Moving-Arm Disk Drive, and two magnetic-tape units (800/1600 bpi)

1982

- Installation of an IBM 4341-1 local process-control computer with 4 MB main memory, five IBM 3350 disk drives, and four IBM 3420 magnetic-tape units (1600/6250 bpi)

1983

- Installation of a Siemens 7.870 computer for the administration, with 6 MB main memory and seven IBM 3350 disk drives /41
- Increase/Reduction in display units to
 - 70 IBM 327x units
 - 60 Ericsson 4110 units
 - 5 Siemens 8160 units
 - 5 Siemens 3886 units
 - 3 Tektronix 4014 units
- Expansion of the VAX 780 local process-control computer from 1 MB to 3 MB main memory and addition of one RA81 (420 MB) disk drive
- Replacement of Benson pen-plotter by an electrostatic Benson plotter
- Replacement of IBM magnetic-tape units by MEMOREX magnetic-tape units

5.5 Stuttgart Computing Center

The computing center in Stuttgart has been operating its local computer since 1968 in a user cooperative with the computing center (RZB) of the Bau GmbH, a subsidiary of the Zueblin firm. The computing center is based in Stuttgart-Vaihingen (on Schulze-Delitzschstr.) about 5 km from the DFVLR research station in the Pfaffenwald.

The Stuttgart computing center supplies terminals, printers, and graphics display units to users in substations in the Pfaffenwald as well as to users in the Lampoldshausen branch.

Since 1977, a Siemens computer running under the BS2000 operating system has been operative in Stuttgart. Since 1978, the computer has been linked to the DFVLR computer network via the so-called Mannheim-Heidelberg coupling; as of 1983, it has been linked to this network via SNATCH as well. Thus, from every terminal in Lampoldshausen, in the Pfaffenwald, and in the Schulze-Delitzschstr. branch, access can be gained both to the BS2000 system and to the IBM computer in Oberpfaffenhofen. Printed output from both systems can be obtained on the

same printer.

For years, the Stuttgart computing center has been attempting to /42 move its base to the research center in the Pfaffenwald. The new computing-center facilities in the Pfaffenwald should be ready for occupation in 1984. The user cooperative will be dissolved at that time. Like all the other DFVLR stations, the Stuttgart computing center will obtain an IBM-compatible data-processing system.

Since 1979, the Stuttgart computing center has also been working in the area of process-control computer technology. A local process-control computer has already been installed in the substation in the Pfaffenwald. It is available for the purpose of program development and testing, and allows laboratory computers access to central resources such as mass memory, special peripheral equipment, and special software.

The following provides an overview of the expansion of the data-processing systems in Stuttgart.

1977

- Installation of a Siemens 7.748 running under the BS2000 operating system, along with
 - 4 display units, 1 printer in the computing center
 - 4 display units, 1 printer in the Pfaffenwald
 - 2 display units, 1 printer in Lampoldshausen

1978

- Expansion of the main memory from 1 MB to 2 MB
- Installation of the Mannheim-Heidelberg coupling; emulation of an IBM HASP Multileaving RJE-station in the Siemens BS2000 system in Stuttgart; coupling to the IBM computers in Oberpfaffenhofen

1979

- Exchange of 7.748 central processing unit for the more efficient 7.760
- Supplementation of peripheral equipment by magnetic-tape drives, high-speed printers, and display units
- Installation of the first IBM display units for interactive communication with computers in Oberpfaffenhofen

1980

- Installation of 5 fixed-head tape drives (420 MB)
- Installation of DUET data-teletransmission control

/43

- Replacement of old magnetic-tape unit by new one capable of switching from 800 to 1600 bpi

1981

- Exchange of the 7.760 with 2 MB for a 7.551 with 4 MB
- Connection of a Tektronix 4014 graphics work-station w. hardcopy in the Pfaffenwald
- Installation of the PDP 11/44 local process-control computer running under RSX-11M; commencement of creation of local process-control computer network using MININET network software

1982

- Exchange of 4 moving-arm disks for fixed-head disks (420 MB)
- Installation of a Siemens 9663 station computer with printing station in the Pfaffenwald
- Expansion of the main memory of the PDP 11/44 local process-control computer; connection of additional PDP 11 computers to the local network; additional installation of an RT 11 operating system

1983

- Installation of SNATCH software for coupling of the BS2000 system in Stuttgart with the IBM SNA-network of the other DFVLR stations

5.6 Oberpfaffenhofen Computing Center

/44

The tumultuous development of the Oberpfaffenhofen computing center since 1977 was shaped by user desires (faster, more reliable, simpler, less expensive new features), by technological developments, and by available funding. An attempt was made to minimize for users the disruption that such change inevitably causes, and this attempt succeeded in most cases. Figure 5 shows that, on the average, a good 40% of the total budget was devoted to the Oberpfaffenhofen computing center in the last five years. Figure 6 shows the breakdown of the Oberpfaffenhofen budget allocation into different areas.

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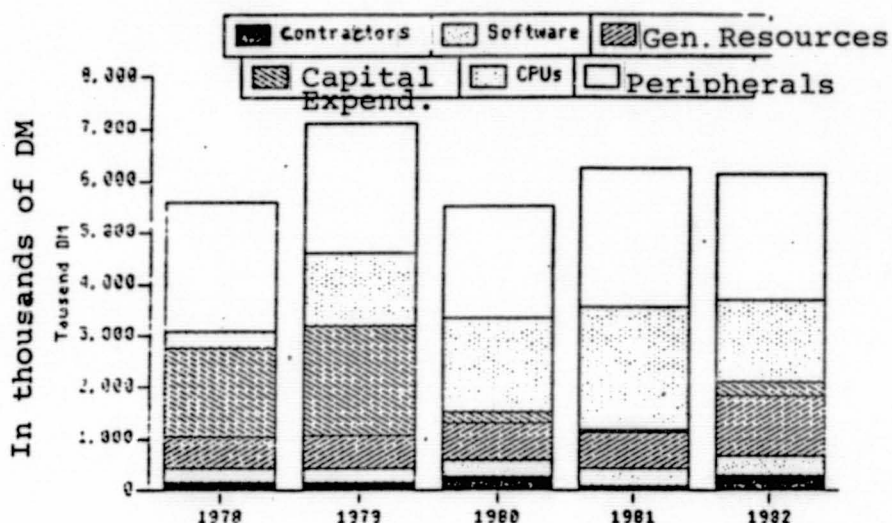


Fig. 5. Sequence of Expenditures for the Oberpfaffenhofen Computing Center (expressed in thousands of DM).

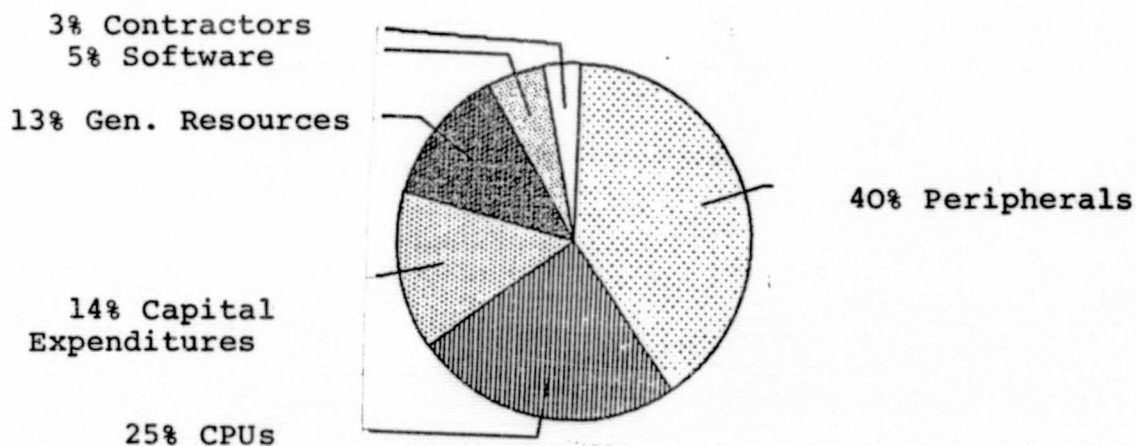


Fig. 6. Breakdown of Expenditures (Mean Values, 1978-1982) for the Oberpfaffenhofen Computing Center.

The following main applications

- Numerical mathematics
- Mass data processing and
- Program developments in timesharing

required increasing CPU performance and expanding main and external memories, as well as input and output, and teleprocessing. Some of these developments are represented in Figs. 7-10:

- CPU performance in MIPS (Million Instructions per Second) was increased from 4 MIPS in 1977 to 15 MPS. Since 1983, an additional 80 MIPS have been available through the CRAY 1-S vector computer for special applications in numerical mathematics
- Size of main memory was enlarged from 4 MB to 24 MB (with future expansion planned to 32 MB by end of 1983) in order to maintain acceptable response times in interactive mode /46
- Applications in Oberpfaffenhofen are heavily batch-oriented. The load of the central processing unit attributable to batch-processing tasks is clearly increasing, at an average annual growth rate of 40%. Even the load in timesharing is rising 34% annually; this, however, represents only 1/10 of total consumption.

Figure 9 shows the absolute CPU hours charged to users (not including system overhead), whereas Fig. 10 shows the normalized consumption in MIPS*CPU hrs. (=instructions). The adaptation and saturation phases prior to system expansion in 1979 and 1982 are quite apparent.

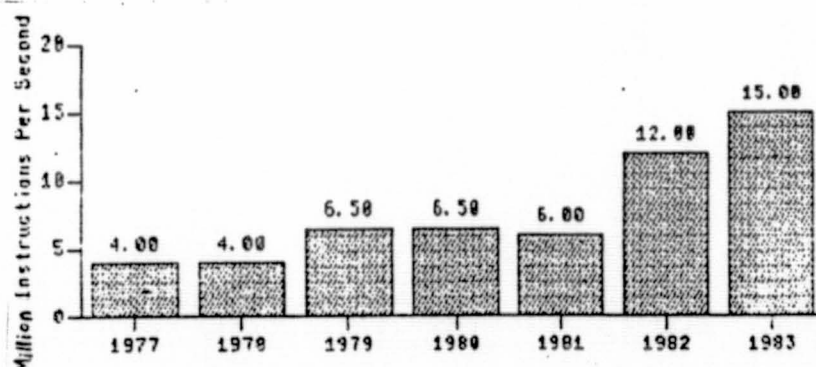


Fig. 7. Evolution of the Central Batch-Processing Computer at the Oberpfaffenhofen Computing Center with Regard to CPU Performance in MIPS.

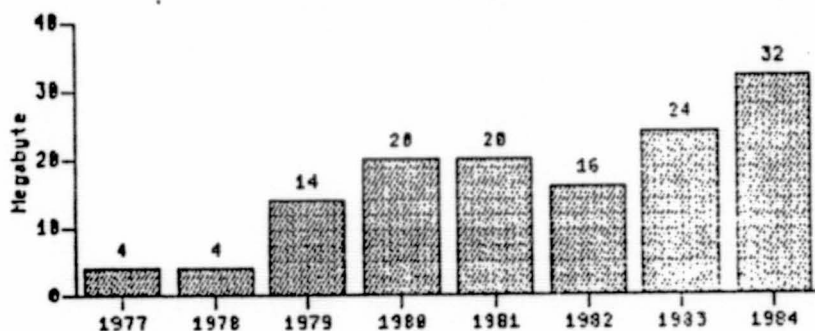


Fig. 8. Evolution of the Central Batch-Processing Computer at the Oberpfaffenhofen Computing Center with Respect to CPU Main Memory in Megabytes.

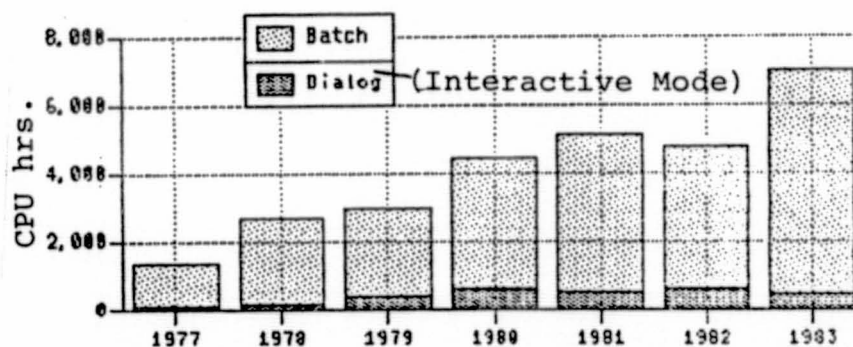


Fig. 9. Evolution of CPU Time (not including system overhead) Charged to Users of the Central Batch-Processing Computer at Oberpfaffenhofen Computing Center.

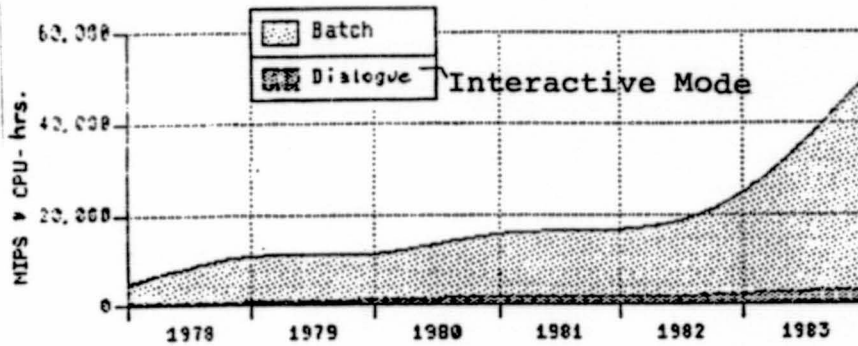


Fig. 10. Evolution of the Normalized CPU Consumption in MIPS*CPU hrs. (=Instructions) of the Central Batch-Processing Computer at Oberpfaffenhofen Computing Center.

Similar developments could be noted with respect to I/O, due to increases in the number of CPU channels and augmentation of direct-access storage capacity (disk and mass storage).

An overview of developments during the past five years is presented in the following (also see Fig. 11).

1977

- Release of the Amdahl V/6 under MVS 3.7 to users, and disassembly of the Telefunken TR 440
- Commencement of timesharing operation
- 29 user terminals
- Linking of RJE [Remote Job Entry] stations and remote terminals in the Braunschweig, Göttingen, Köln, and Stuttgart computing centers via private lines with 2 x 4800 bps

1978

- Direct-access storage capacity increased to 3000 MB
- Connection of additional remote terminals
- Initial testing of SNA products

1979

- Occupation of new computing-center facility
- Enhancement of performance by putting into operation the IBM 3032 with 6 MB under MVS 3.7H
- Putting IBM 3850 mass-memory system into operation (capacity of 100 GB)

- 50 user terminals
- On-line Versatec plotter
- Expansion of lines to other computing centers to 2 x 9600 bps; separation of batch-processing and timesharing

1980

- Expansion of main memories by 10 MB (in the case of Amdahl from 4 to 8 MB and in case of IBM from 6 to 12 MB)
- MVS-SE2 operating system
- Uniform IBM 3350 disk models
- Enlargement of the mass memory with second staging adapter and doubling of storage capacity
- Conversion of the TCAM dialogue monitor to VTAM, and putting the JES 2/NJE into operation

1981

- SNA Cross-Domain to Braunschweig, Göttingen, and Köln computing centers
- Replacement of IBM 3032 by Siemens 7.865-2, maintaining same real memory capacity
- Making an ADV-terminal network and IMS/CICS data bank system available for use

1982

- Replacement of the double computer system by an IBM 3081-D with 16 MB main memory under the MVS-SP 1.1 operating system /50
- Earmarking of the Siemens 7.865 for VM and MVS development
- SNA Cross-Domain Communication with 19.2 kbps as "parallel lines"
- Emptying of Level-1 files from MSS onto real disks
- IBM 6670 laser printer for text output
- At end of year, increase of CPU performance by model alteration on IBM 3081-K with 24 MB main memory under MVS-SP 1.3 operating system

1983

- Release of Cray 1-S parallel computer for use
- Putting uninterruptable electric power supply into operation
- Release of VM/CMS operating system to the 7.865 system

- Partial replacement of 3350 disk model by 3380 /51
- Exchange of IBM 3081-K central processing unit for more economical 3081-D model, with increase in main memory to 32 MB

CPUs

Peripherals

Data Transmission

Operating Systems

System Components

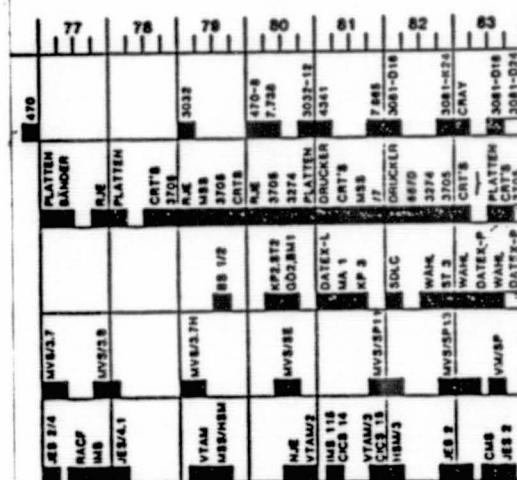


Fig. 11. Milestones During the Past Five Years of the Central Batch-Processing Computer at the Oberpfaffenhofen Computing Center.

[Platten = Disks, Bänder = Tapes, Drucker = Printer]

6. Maintenance and Adaptation of Operating and User Systems

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The further development and adaptation of operating and program systems represents a key area of endeavor for the Dept. for Central Data Processing, since the productivity of computers installed in the computing center depends, in the final analysis, on the efficiency and characteristics of these systems. Expansions and improvements in hardware remain ineffectual if they are not supported and utilized by carefully tailored software.

Included in this broad area of concern are:

- Maintenance, adaptation, and supplementation of operating systems for general-purpose and local process-control computers
- Preparation and implementation of procedures and adjunct programs for particular needs of DFVLR

- Testing, selection, improvement, and adaptation of user software
- Selection, acquisition, adaptation, and maintenance of program libraries for processing of both scientific data and administrative data; testing and making available programming tools and aids of all kinds
- Maintenance, adaptation, and improvement of user interfaces for operating and user systems.

Clearly, these tasks are closely allied with all the other tasks of the Dept. for Central Data Processing, since adaptation and further development of software systems are the foundations on which daily operation rests--a foundation without which, in the final analysis, daily operations in a research institute like the DFVLR could not exist. On the other hand, adaptation and maintenance in many cases build in turn on results obtained in other task groups of the Dept. for Central Data Processing that are involved to some degree in work of a fundamental nature.

6.1 Operating Systems

/53

In past years, the work of the Dept. for Central Data Processing was directed toward providing users at all data-processing sites of the Main Dept. with uniform interfaces and access opportunities. The characteristics of a given data-processing system are determined by the technical features of the system (hardware) and, moreover, by the characteristics of the operating system employed on the computer. To date, then, computers with IBM structure and uniform operating systems have been deliberately introduced into the Braunschweig, Göttingen, and Oberpfaffenhofen sites, within the bounds set by technical and contractual considerations.

During the past year, however, altered technical and financial parameters forced a reconsideration of this basic plan and accommodation to the changed situation. Examples of some of the most important changes can be given here:

- The technological development of small-computer systems (Personal Computer) has advanced with extraordinary speed. Systems are now available on the market which, for certain applications, are as reasonably priced or even less expensive than traditional general-purpose computers, and which offer features that the Dept. for Central Data Processing has not offered thus far.
- In keeping with general economic developments, financial considerations are becoming more and more restrictive for data-processing facilities, which are now compelled to search even more concertedly for reasonably-priced solutions to their needs in order to remain competitive.
- The Dept. for Central Data Processing can ensure its existence in the long run only by continually opening up new fields of application--before other solutions have been found in these

areas.

These factors were important considerations in the decision of the Dept. for Central Data Processing to use a variety of different operating systems in routine operation, if greater productivity and increased cost-effectiveness could be achieved thereby in different areas of application. This decision was made despite the problems /54 inevitably arising from the employment of heterogenous systems.

The preceding, along with the existence of the DFVLR computer network, served to create the underpinnings of the strategy adopted by the Dept. for Central Data Processing:

Interactive mode at the individual sites

Batch-processing performed centrally in Oberpfaffenhofen

This general plan makes it possible to provide all users in the DFVLR with appropriate services in a cost-effective manner.

6.1.1 The MVS Operating System

The OS/MVS Operating System (IBM) continues to serve as the central operating system for general-purpose computers in the Main Dept. for Central Data Processing.

It consists of a cost-free core, supplemented by components that must be licensed. It is precisely these cost-labile supplemental products that make utilization practical in the first place. Thus, products like the Resource Access Control Facility (RACF), Hierarchical Storage Manager (HSM), and access methods for dialogue control and remote data processing have been installed in the SNA computer network of the DFVLR as expansions of the operating system that are subject to license.

Rising demands on the part of users made it necessary to supplement the actual system core with System Enhancement (SE) in order to achieve marked improvement in response times during interactive transactions, and thereby support an increased number of users utilizing the interactive mode.

With procurement of the new IBM 3081 equipment (considerably more efficient and substantially cheaper than the configuration in place up to that point), it was necessary to install the MVS-SP 1.1 version of the operating system as well, which is functionally almost identical to the MVS-SE2 version operating previously. (The performance range of the various MVS versions has been described in its essentials in the 1981 annual report of the Dept. for Central Data Processing.) In the course of 1982, this system version was adopted for the other /55 equipment with IBM structure in Braunschweig and Göttingen as well.

The expansion of the IBM 3081 to a Model K with 24 MB at the end of 1982 made simultaneous conversion to the MVS-SP 1.3 version necessary, since only this system version can support main memory capacities of more than 16 MB. This version will be adopted this year on the computers in Braunschweig and Göttingen.

6.1.2 The VM Operating System

Putting VM/CMS Into Operation

After the VM Operating System with CMS had been tried out on the test machine in Oberpfaffenhofen in 1981 (see Report on Test Results [Ergebnisbericht], 1981), the greater part of 1982 was devoted to installing VM/CMS in Köln-Porz and to making it available for use.

Installation of the operating system began at the end of April, after the IBM 4341 from Oberpfaffenhofen had been assembled. The scheduled date of release to users was the beginning of June. Users who had been working under the BS2000 had about two months--i.e., until the beginning of August--to change over their programs (thus far running on the Siemens BS2000 system) to CMS. Then, at the beginning of August, BS2000 operation was suspended for scientific users.

The methods developed in the preceding months for installing and maintaining VM system components proved successful. In accord with these methods, each component is installed on a different minidisk and is managed by its own user ID. "Pure" VM products are each handled according to the maintenance scheme prescribed by IBM. In the case of VM-alien products (whether manufactured by IBM or some other concern), suppliers generally remain silent on the issue of how the product should be installed and maintained. A procedure was developed for these products that is similar to routine VM maintenance and consequently suited to the system.

All activities performed or to be performed during installation /56 and maintenance phases were documented to the extent that they depart from or go beyond instructions in the manuals. Although everyone understands in theory how useful such documentation is, experience has shown that, contrary to all directives, it is often not supplied, or supplied only with reluctance. Any documentation, however, is useful only to the extent that it remains relevant to current conditions. In order to remove any stumbling blocks, we refrained from imposing very formal rules on this type of documentation. It is always stored at the appropriate product on a "working minidisk", to which every maintenance-user ID has access.

A system that is set up and documented in this way simplifies daily work for the persons responsible for a product and makes it easier for new staff to become familiar with the system. Provision of practical, joint systems maintenance by systems personnel who are geographically removed from each other--certainly the case for the DFVLR--first becomes possible in this way.

Joint systems maintenance, however, requires uniform conditions at all the sites. To demand complete standardization, however, is unrealistic. At every site, there are special demands on the system that are in part historically determined, in part related to the particular kind of research conducted at the site. These differences characterizing the individual sites--differences that constitute the smaller portion of user interface of the system--must nevertheless not compromise the uniformity of the other, far greater portion.

The contradiction between the demand for a uniform system on the one hand and for features tailored to the needs of individual sites on the other can be resolved only if the user interface is cleanly separated into a site-specific part and a DFVLR-aligned (i.e. uniform) part. Such a division can be realized easily in VM/CMS. In this system, provision is already made for dividing up user software onto minidisks that are managed independently of one another. Maintenance of site-specific software can be neatly separated from maintenance of the overall system. From a very early point, the need to accommodate site-tailored software was demonstrated in Köln-Porz. The concept of separation proved successful from the very beginning. /57

Experiences Gained From Operation of VM/CMS

In the course of past years, two groups of users emerged in Köln-Porz--one that used the Siemens BS2000 system in Köln-Porz exclusively and one that used the IBM MVS-System in Oberpfaffenhofen exclusively. There was, in addition, a small group of users who worked under both systems. The goal of switching users of the BS2000 over to VM/CMS was to be accomplished in its first phase with the release of VM to users. The MVS users were to continue to work under the MVS system in Oberpfaffenhofen as before.

The conversion from BS 2000 to VM/CMS went quite smoothly for the most part. The new system was accepted very readily by the users. Use of CMS proved to be uncomplicated and easily mastered. The conversion was facilitated by the fact that the user interfaces of BS2000 and CMS resemble each other strongly at many points. Initial difficulties aside, operators were able to run the system without problems.

It proved far more difficult, however, to assure the MVS users smooth access to the system in Oberpfaffenhofen. To do so, the VM system had to be incorporated into the existing SNA network. First, an MVS system running under VM was chosen as the SNA carrier system. Since this system only serves communication from Köln-Porz to Oberpfaffenhofen, it was possible to design it to be very small. Nevertheless, it tied up almost half of equipment capacity. To make matters worse, response times in interactive mode with Oberpfaffenhofen were highly unsatisfactory. Tuning was able to mitigate this ill but did not succeed in eradicating it altogether. It became apparent here that it is not reasonable--at least on small equipment--to employ MVS under VM in routine operation. Thus, to improve response times in interactive communications with Oberpfaffenhofen, the MVS had to be replaced by another system. Systems found suitable for this include the DOS-System, which runs very efficiently under VM, and the

VM product Pass-Through.

When the ADV computer is installed at the Köln-Porz site in Fall /58 1983, the MVS operating system running on this computer will take over the function of the SNA carrier system. The storage space thus far occupied by the virtual MVS system can be made available to the scientific users. In this way, the interactive mode at the Köln-Porz site can be further improved.

The second phase involves the attempt to win MVS-users in Köln-Porz--as well as MVS-users at all the other sites--over to the VM/CMS system. Only after this has been accomplished can the goal of the long-range plan be reached--namely, to carry out program development in interactive mode under CMS at the individual sites and to conduct batch-processing centrally under MVS in Oberpfaffenhofen. For this, the VM must first be made available at the other sites. VM was installed in Göttingen at the close of 1982; plans call for its installation in Braunschweig and Stuttgart in the near future.

VM also opens up areas of utilization, however, that go well beyond service to traditional users of data processing as witnessed thus far. With the VM system (using the same computer equipment and with the same response times), substantially more video display screens can be operated in interactive mode than is possible with the MVS/TSO system. That ultimately translates to mean that the cost per video-screen work station is lowered.

To be able to install more and cheaper video-display screen work stations also means to be able to introduce new, interactively-oriented applications. Data processing can thus be offered to work sites to which it was previously inaccessible. Thus, in Fall 1982--in a cooperative arrangement with IBM--the IBM EPOS/80 product was installed for trial. This is a video-display-screen oriented system, by means of which correspondence and appointment schedules (for example) can be managed by computer. The target group of this system includes management personnel at all levels.

Offering an operating system that is easy to learn and use also means being in a position to win those staff persons over to data processing who to date have found traditional data processing on large computers arduous, impenetrable, and ultimately unlearnable.

The introduction of VM/CMS can also be seen as an initial response to the challenge emanating from the increasingly less expensive /59 personal computers. In the still unpredictable personal-computer market, every buyer runs the risk of isolation, since many of the systems offered today will fall by the wayside in the course of market competition. In this regard, VM/CMS can help safeguard against chaotic development in the DFVLR.

6.1.3 New Operating Systems

VM should not be interpreted solely as an alternative to acquiring personal computers, however. It has already become clear that the UNIX

operating system (developed by Bell Laboratories) will assume an important position in the small-computer market. This system can be run under VM. In the case of one well-known manufacturer, UNIX has already been implemented under VM. Another interesting development, currently running in a laboratory, consists of installing CMS on microcomputers. Various possibilities emerge here--e.g., of the way in which personal computers and large computers operating under VM can complement each other in a meaningful way. The users of personal computers can have the capabilities of the large computer at their disposal, without having to contend with different interfaces. One of the most important tasks in the years to come will be to follow developments in this area closely and to respond to them in a timely fashion.

The first studies investigating the possibility of employing personal computers in the DFVLR for the purposes of various user groups are currently being conducted in the Main Dept. for Central Data Processing. Presently, the UNIX operating system is being studied intensively on a personal computer manufactured by Periphore Computer Systems (PCS). This study should produce some statement concerning the possibilities of using such components in conjunction with large-computer systems installed at the DFVLR.

6.2 User Systems

In the following sections, we will go just briefly into the most important data management systems supervised by the Main Dept. Additional user systems will be discussed extensively in Sections 7, 10, 11, and 13, among others. /60

IMS

The IMS data-bank system has been available on the central computer in Oberpfaffenhofen for some time, but has increased in importance considerably since administrative data processing was converted to on-line systems.

Data-bank systems, too, must be adapted continually to advances in technology and to new versions of operating systems. Extensive planning is imperative when setting up data bases, since their fundamental structure, on which a multitude of user programs are built, cannot be altered at a later date without considerable cost. Consequently, an attempt to anticipate future developments must be made to the extent possible during the original planning phase.

CICS

In the past, only the IMS data-bank system (IMS/DB)--without its own access mechanism--was available on data-processing systems of the Dept. for Central Data Processing. It was utilized in "normal" interactive applications under TSO. Where a large number of terminals are being operated, however, a separate access system for data banks is considerably more economical. For this reason, the CICS system

(Customer Information Control System)--which requires much less than IMS/DC in the way of system resources--was selected and implemented.

This product, too, must be continually maintained and developed.

SQL

/61

The product SQL (Structured Query Language) was implemented under the DOS operating system for the purposes of personnel management. With this product, it is possible to pose ad hoc queries to data banks, without it being necessary for special applications programs to be developed for such cases.

The SQL system is extremely user-friendly. It offers many features that can be utilized economically and to good purpose not only for administrative tasks but in scientific and technical applications as well. It is particularly helpful in the evaluation of experimental data, which constitutes a large part of the scientific and technical applications. The Dept. for Central Data Processing is presently making a great effort to prepare this product for the DFVLR, so that it can be made available to users as soon as possible.

The advice and support to the user represent the core of the work of central data processing, in which persons from all sections take part. Since data processing systems from different manufacturers are installed in the DFVLR (Federal German Aeronautics and Space Center), more workers must be assigned to this central mission than would be necessary in a homogeneously equipped computer center. Moreover, already because of the great variety of the research products which are treated in the DFVLR a specially broad spectrum of problems and questions be considered which are involved in the Central Data Processing.

This group of problems includes:

- general advice to the users in the search for defects
- general advice over program libraries, program organization, programming techniques
- advice and support in problems of software engineering and data organization
- scientific advice in problem analyses, in the selection and adjustment of mathematical methods
- establishment and adjustment of subprograms and procedures
- software support by problem analysis and establishment of sets of solutions until the complete working out of data processing problems including the programming.

The outlay with which the Central Data Processing supports the individual users or user groups (establishments or projects) can range from several hours up to several man years. But even if the workers of the Central Data Processing are connected over a long period with a very definite project, such as for example in the case of the support of the project of the German-Dutch wind tunnel, on a long-term basis the experience and the knowledge which has appeared in such special cases benefits again all the users in the DFVLR.

7.1 Program Libraries and Programming Aids

/63

For the different system environments and languages to an increasing extent, besides the indispensable program libraries and special programs, increasingly complex and costly software products are being promoted and offered on the markets, which integrate different components through a

comfortable and reliably simple user interface and have a broad spectrum of possibilities of application. Examples of this are modern statistical packets such as the SAS and auxiliary programs for the software engineering which can be introduced in the dialogue and in the stacking operation as well as for scientific programs, also to solve administrative or commercial problems.

The indicated development increases the need of coordinating and providing systematically for establishing software with suitable aids, maintaining and documenting them.

The WT-DV carried out market and requirement analyses as well as product comparisons for mathematical and technical software with the long-term goal of extending suitably the supply to the users in accordance with the requirements, the trend and the means available to the WT-DV, and specifically with the following main elements now:

- Program libraries and combination into a method bank,
- Integrated systems to evaluate measurement data with the methods of statistics and digital signal processing,
- Software tools,
- Information material on software products and solutions of problems.

These studies were also conducted with regard to the installation of a CRAY and the release of APL under VM/CMS. They were also used to prepare a planned joint study with the IBM on an integrated data analysis and management system (IDAMS) which will be studied primarily within the framework of a six month preliminary study up to the end of 1983.

The first results include the substitution of the statistical packets SPSS by SAS on the IBM 3081 and the forthcoming implementation of DATS 11 on the VAX in Goettingen to evaluate the measurement data. The program packet of the IEEE for the digital signal processing should as far as possible be released simultaneously for the CRAY and the location computer. /64

Moreover it is provided to install the tool pack system developed by various institutions in America, which integrate different software tools for the establishment, analysis and documentation of FORTRAN programs and a file system for programs and test data.

The investigations of other program systems from the areas indicated are continued and specifically set up increasingly on the maximum capacity computer CRAY 1S. Various catalogues, descriptions and comparisons of software products are available to the users.

7.1.1 Mathematical Libraries

Since September 1980 the IMSL (International Mathematical and Statistical Libraries) are available uniformly in all locations. This extensive collection of subprograms is thus in the entire DFVLR a standard library for digital mathematical methods. Besides this the Central Data Processing has prepared a whole series of additional libraries and makes them available to the users:

| | |
|---------|--|
| BSPLINE | Interpolation and Approximation |
| EISPACK | Solution of Eigenvalue Problems |
| HAROPT | Linear and Nonlinear Optimizing with Linear and Nonlinear Secondary Conditions |
| ITPACK | Iteration Method to Solve Large Linear Systems of Equations with Weakly Occupied Symmetrical Positively Defined Matrices |
| LINPACK | Linear Algebra |
| LLSQ | Compensation Calculation (Least Squares Problems) |
| RZLIB | Subprograms Made Available by the Computer Center. |

Each of these libraries of subprograms is described in one or several handbooks, which are independent of each other and very different in their details and in the type of representation. This diversity impedes the user in the search and in the selection of suitable subprograms. If in particular several subprograms are available for the same group of problems in different libraries, it is often difficult to establish which is the suitable one. /65

Therefore the Central Data Processing has supplemented most descriptions of the subprogram libraries wherever necessary and set them up uniformly according to the pattern of the IMSL³⁾.

7.1.2 The NUMERIX Information System

NUMERIX is an information program developed in the Central Data Processing, with which the user can see the initial comments of all the subprogram libraries offered. For practical work there are two further aids to the user offered by NUMERIX, and which are particularly helpful:

--A survey can be obtained about the mathematical subprograms available in the Computer Center, by indicating or printing on the display screen the content data of the program group. In particular, descriptions of all subprograms of a group of problems can be indicated independently of the library to which these subprograms belong.

³⁾ To maintain this pattern exactly was impossible for all subprograms because of the considerable cost, and also because it was not reasonable in case of well-documented libraries because of the ratio of costs to the possible improvements. But it was achieved approximately for most libraries. The LLSQ and HAROPT cannot be worked out within a foreseeable time because of the want of personnel.

--Information may be obtained in "tutorials" of characteristics of the individual libraries.

NUMERIX works just like the SPF in menu technique and is controlled by the user through inputs and by means of the PF keys. Help screens are available for the menus discussing the possible inputs in greater detail. For each program library moreover a tutorial is available which contains the details of the application of this program library.

/66

The description of the subprograms are stored in a VSAM-data file, the individual type of access are stored by two auxiliary data files and set keys. If the descriptions change or a new program library must be connected, only these data files need to be changed, while the program itself remains unaltered.

7.2 Project of the German-Dutch Wind Tunnel (DNW)

This project is a characteristic example of the support of the user through the main section of the Central Data Processing within the framework of a certain firmly outlined problem which extends in this case over several years.

The German-Dutch Wind Tunnel (DNW) is a low speed wind tunnel with exchangeable measurement distances which is available to all establishments from the industry and research, especially the aircraft industry, which deal with problems of aerodynamics. It was established as an independent establishment of the two national research organizations National Lucht- en Ruimtevaartlaboratorium (National Air and Space Laboratory) and the Deutsche Forschungs- und Versuchsanstalt fuer Luft und Raumfahrt (DFVLR). The parent associations cooperated from the beginning in the planning and layout of the DNW.

7.2.1 Planning

From the beginning the Main Section of the Central Data Processing, besides other institutions of the DFVLR collaborated with the technical divisions of the NLR in the development and implementation of the concept for data processing within the framework of a functional support and later a finalization support. The purpose of this collaboration was to provide the experience of the DFVLR as one of the parent associations and to establish a totally automatic computer supported experimental plant.

In 1977 the data processing concept was established including a proposal for computer selection. It was christened:

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SNW-DARS (Data Acquisition and Reduction System)

and provides for a computer network in which the functions are distributed over several computers.

The computer network consists of several subsystems:

- the MARS operational system (measurement, evaluation, regulation, and control) and
- the preparation and back-up system VENUS (preparation, calibration, adjustment and simulation).

MARS and VENUS were connected in the shape of star each with one leading computer as nodes and further subsystems to support the individual components of the DNW. The networks are connected with each other.

7.2.2 Implementation

The Central Data Processing has taken up within the framework of functional support the design and implementation of the total software for the leading computer of MARS and its subsystems as well as for the corresponding components of VENUS, except for the subsystem for the external balance. The software for the experimental evaluation and its components in VENUS is being developed for the NLR.

In 1978 the design and implementation of software started. This included the studies for the software

- ..of the leading computer,
- ..the network protocol and
- ..the subsystems
 - STS (Sting Support System);
 - SDA (Static Data Acquisition);
 - WTC (Wind Tunnel Control).

In the middle of 1980 the software had reached a level in the preliminary variant which permitted a limited operation of the tunnel. At the beginning of 1981 an important milestone was reached with the ready for operation level, which allowed a semiautomatic experimental operation including the subsystem WTC, SDA, STS with pregiven nominal value. /68

7.2.3 Finalization Support

On the basis of the first experience the studies continued. They include:

- ..the development of a subsystem for acoustic measurements (ADA);
- ..in collaboration with the DNW the development of a subsystem for the power unit simulation (TPS);
- ..the establishment of the components for VENUS;
- ..the reworking of the operator interface for the totally automatic experimental operation (setpointing and scheduling: SAS);
- ..integration of the EXB.

As a consequence of important requirements, the meshing of the MARS network was implemented.

Finally studies are being carried out for:

- ..the finishing and implementation,
- ..the software for totally automatic operation,
- ..the subsystem for acoustic measurements,
- ..a comprehensive extension of the on-line data presentation on the leading computer independently of the evaluation of the tests.

7.3 Training

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Special attention was devoted by the Central Data Processing to training and advanced training of the users. Because more than other institutions of the DFVLR the Central Data Processing offers tools which are used by the users themselves and are often modified and adjusted to their requirements. But this is only possible if the users are sufficiently acquainted and knowledgeable about the programs and program systems offered by the Central Data Processing, how they can be applied reasonably and economically.

In many training courses and lectures therefore in all locations the users are instructed about the properties of the data processing systems installed in the DFVLR with new program products and system components, with mathematical methods and programming speeches.

The group of topics for training and advanced training includes the very time consuming establishment of the training documents and the care of the documentation for the many program products. This problem, without which a reasonable and economic use of the data processing system is not possible at all, requires a considerable amount of the personal capacity of the main section, when this problem has to be solved to an increasing extent by means of computer supported text processing.

To the extent to which the data processing is penetrating also in areas which have nothing or little to do with the classical areas of digital data processing, the main division has in addition the problem of introducing workers to the working procedure and reasoning of electronic data processing, while these workers had previously solved their problems with totally different aids and methods. Text processing, graphs, office automation, information management are catchwords which indicate entirely new working regions of the Central Data Processing. Since they correspond at least partly to an entirely new group of users, they also raise totally new problems for training and care for the main division in the training of mathematical and technical assistance to which the Central Data Processing has devoted itself for several years, and on which a report is given in Section 14, page 132.

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8. Computer Networks and Communications

Computer Concept and Computer Networks

The computer concept of the DFVLR from 1976 provided data processing plants of medium capacity in all research centers of the DFVLR as well as a central large computer in Oberpfaffenhofen with which even higher requirements for computer capacity could be satisfied. This concept requires necessarily that users from the remaining locations can have access to the central large computer.

With the first large computer Amdahl 470 V/6 therefore besides Oberpfaffenhofen dialogue instruments and stacking stations were installed in four research centers which were connected directly with the central large computer. This type of supply corresponded in 1977 very well to the state of the art, but was not satisfactory for the users of the computer center.

Therefore great efforts were made in the Central Data Processing to set up a computer network on the basis of the SNA concept. This SNA concept connects today all the data processing plants with IBM structure with each other and allows the access of all instruments to the centrally located large computers in Oberpfaffenhofen.

In the connection of the universal computers in the DFVLR a special role was played by the project SNATCH. Only with the results and experience of this project was it possible to connect with each other computers by different manufacturers into a common network (section 8.1 gives details on this).

Another great step forwards on the way to a well built up computer network which is applicable for many problems was the decision to include the process computers existing in large numbers into an integrated data processing supply system and thus create an overall more economic and more powerful process data processing procedure (see section 9).

Local Networks

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The DFVLR tackled already very early the problem of the local networks (Local Area Networks - LAN). The process computers existing in large numbers have to be included in the general data processing supply system so that the requirements on the central operating means are reduced and thus the process computer system scattered in all the establishments could be operated more economically than previously.

Already in 1978 a set of solutions for connecting process computers developed by the Association for Heavy Ion Research (GS), Darmstadt, to

the company Digital Equipment on the request of the DFVLR, a concept which today can still compete with the components offered on the market. This concept makes it possible for the data from processes with high data rates to be transmitted from and to the local computers available on the site.

Goals

The goal of the studies of the Central Data Processing is to extend the local networks and prepare them for new areas of application. The catchwords process data processing, text processing, office communications and working place systems play a prominent role in this connection. Naturally the normalization and standardization in this region has not progressed so far that the local networks can immediately be available on call for these applications. However the development in this area has been followed attentively by the Central Data Processing so that this service can be offered at the earliest possible time for users in the DFVLR.

8.1 The SNATCH Project

8.1.1 Purpose of the Project

With the connection of the five computer centers in Oberpfaffenhofen, Goettingen, Braunschweig, Koeln-Porz and Stuttgart to a main division in the DFVLR the organizational prerequisites were also obtained for a computer network. This network was to connect in future the universal computer in the locations with each other in such a way that the workers of the DFVLR of all five research centers could have access to the power spectrum of all the connected systems. /75

The special element of this statement of the problem was that a heterogeneous connection of the Siemens and IBM systems had to be created. Because in the DFVLR then (and even today) both Siemens plants with the BS2000 operating system and IBM plants or IBM compatible plants with the MVS operating system are used. The statement of the problem arising from this situation can be outlined briefly:

Both IBM and Siemens offer hard and software products, with which their own data processing systems and final equipments can be connected into networks. These products are based on manufacturers specific system architectures, which establish the rules for the communication, the so-called protocol between the final partners involved (instruments, programs, subsystems) at different logical levels and the possible forms of cross-linking. In the IBM we talk of SNA (SNA = Systems Network Architecture) in Siemens of TRANSDATA networks.

The network systems of both manufacturers allow a user controlled functional connection of the processing computers (hosts), the preliminary computers (front end and network node computers) and the final instruments (terminals). Such a connection offers mainly the following capacities:

- ..access at choice to the different host systems in dialogue operation (time sharing);
- ..access at choice to different host systems in stacking operation (remote job entry);
- ..communication between user programs or subsystems in the same or for different hosts.

Although the capacities of the SNA and TRANSDATA networks are very similar, it is not directly possible to connect with each other the IBM and Siemens system into a heterogeneous functional connection. This statement applies naturally also for systems of other manufacturers, since the communication protocols which are used in the different system architectures are not compatible (incompatible) with those of other manufacturers. The network architectures of the manufacturers existing today are therefore called closed.

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The cause for the occurrence of closed architectures was the want of standards in the area of data communications. A proposal for the implementation of open architectures was proposed for the first time in 1978 and later improved by the ISO (International Organization for Standardization) with its "Reference Model for Open Systems". This model includes seven logical communication layers and gives the framework for the development of uniform protocols.

On the four lower layers the rules are established for:

1. the physical properties of the lines (transmission lines),
2. the structure and processing of news between two neighboring network nodes,
3. the routing of news in the network and
4. the data transmission free from losses between two terminals.

On layers 5 to 7 which lie upon the others, it is regulated how the partners in a network, which could be terminal equipment, programs, program systems and then finally users, can communicate with each other.

For the transport oriented lower four layers of the ISO model meanwhile international standard recommendations are available or are expected shortly. The development of protocols and their standardization for application oriented and therefore more complex higher ISO layers 5 to 7 will however take at least five more years.

The purpose, specifically "openness", that is compatibility of the manufacturer networks has however not yet been reached, for this purpose naturally the manufacturers must implement their own networks according to the ISO architecture, that is they must either replace their previous protocols by the standardized ones or at least provide transitions to them. Whether and where the manufacturers would be prepared to do so cannot be estimated yet today.

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This situation had to be taken into consideration from the beginning with the plans of the DFVLR. Therefore the basic idea of the DFVLR was to start from the network systems now available from the manufacturers and to study on the example of the SNA and TRANSDATA whether the mutual opening of the closed networks is also possible in the sense of the ISO reference model when the products of the manufacturer are introduced unaltered. The product named SNATCH which stands for SNA and TRANSDATA Coupling of Hosts, reflects this procedure.

8.1.2 Method of Solution and Design Criteria

For the SNATCH project the following procedure was selected for the solution: The data processing systems of the manufacturers concerned were connected into a homogeneous, manufacturer specific partial network, that is the systems with IBM structure were connected into an SNA network and the Siemens system with the BS2000 operating system into a TRANSDATA network. Both partial networks are connected with each other through an image forming system, Gateway, on an equality basis into a total network. In this connection the purpose is to transmit the functional connection in each homogeneous manufacturer partial network as completely as possible to the heterogeneous total network.

The Gateway software is implemented with a Siemens network computer. This processor acts as a logical communications channel between both manufacturer partial networks and specifically in such a way that each partial network considers the image forming system and the foreign partial network as a continuation of itself. Only the software in the Gateway "knows" that on one side a TRANSDATA network, and on the other side an SNA network has been connected (Figure 12).

The image forming system converts for this purpose the communication protocol of one network into the corresponding protocol of the other network in both directions. The important steps in this connection are:

- ..the conversion of the protocols of the transport systems and on this basis
- ..the conversion of the higher processing oriented protocols which are used partly outside the architectures, by instruments and software subsystems.

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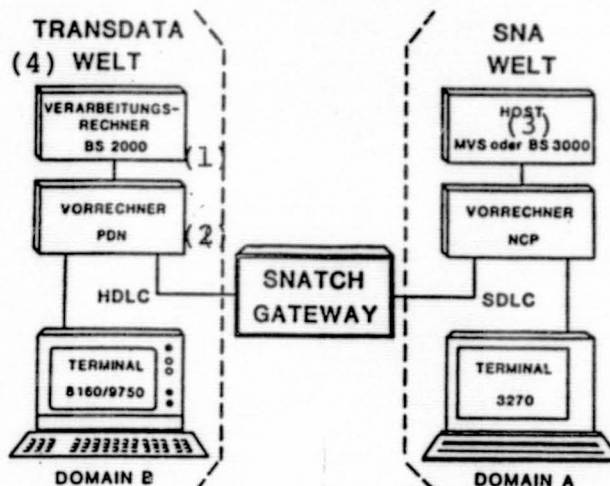


Figure 12: The Gateway concept of SNATCH. Key: (1) processing computer; (2) preliminary computer; (3) or; (4) world.

This method of solution takes into account moreover the following design criteria:

..Symmetrical Connection

All computers (hosts), user stations (terminals) and subsystems (application) take part equally in the connection without limitation of the network architectures involved.

..Invariancy of the Operating Systems

The operating systems of the hosts and the communication computers (front end computers and network node computers) in particular the methods of access for data transmission, can be used without alterations. Thus the maintenance problem can be solved.

..Portability

The total network including the Gateway can be given its configuration by generation. Thus the image forming software can be transferred to cases of application outside the DFVLR.

..Possibility of Extension

The manufacturers' specific protocols are converted through intermediate mutual protocols connected. This leads the possibility open of using if necessary an open packet transmission network on the X.25 base (DATEX-P) and connecting further manufacturer architectures.

8.1.3 Course of the Project and Extent of the Functions

The basic preliminary investigations which led to the described Gateway concept were carried out in 1978 and 1979 in collaboration with Siemens AG. The actual SNATCH project began early in 1980 and was supported by the Federal Ministry for Research and Technology (BMFT). Within the framework of a cooperation agreement with Siemens AG since then the studies have been carried out under the project leadership of the DFVLR by a common team (between 10 and 15 persons) consisting of workers from the DFVLR, Siemens AG and advisors from other software companies in the main division of the Central Data Processing in Oberpfaffenhofen. Since 1981 the team has also been working with the Computer Center of the Mannheim University and since 1982 with the Federal Criminology Office of Wiesbaden (BKA).

By the end of 1982, the original end of the period of support by the BMFT all the planned partial stages of the projects were completed on schedule. In this connection the following functions for the heterogeneous IBM/Siemens computer connection were implemented in a basic variant of SNATCH:

- . Program Connection

Program-program communication through the VTAM- and DCAM- user interfaces (VTAM and DCAM are the methods of access of IBM and Siemens for remote data processing).

- . Dialog Connection

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The dialogue access of Siemens data visual stations to the subsystems to the IBM hosts for subscriber operation (TSO = Time Sharing Option), operation on a share basis (IMS = Information Management System, CICS = Customer Information Control System) and network control (NCCF = Network Communications Control Facility) also in the reverse direction.

Dialog access of the IBM data visualization stations to the subsystems in the Siemens BS 2000 hosts for subscriber operation (TIAM = Terminal Interactive Access Method) and operation on a shared basis (UTM = Universal Transaction Monitor).

- . Network Job Connection (NJE = Network Job Entry)

Transmission of jobs which are collected by an IBM Subsystem for Static Processing JES2/NJE on plates ("on spools") on a Siemens subsystem for stack processing RBAM and inversely. Thus it is also possible to have file transfer between any host computers and the heterogeneous network.

The NJE function requires in the BS2000 host a software system which simulates a JES2 subsystem of the IBM. This software was produced by the Computer Center of the Mannheim University and tested jointly with the SNATCH development team.

Because of the positive results the support period by the BMFT was extended until 30 June 1983 so that the system could be tested in the pilot plant and possibilities of expansion could be studied. Within the framework of cooperation with the BKA during this period additional connection functions were also achieved, specifically:

- . Print-out connection

Print-out of text and data of the IBM subsystems TSO, IMS and CICS or user written VTAM application programs on the printing stations of Siemens, and inversely

Print-out of text and data from the Siemens subsystems TIAM and UTM or user written DCAM application programs on the IBM printing stations.

- . Possibility of connection of Siemens BS1000 systems

8.1.4 Introduction of the SNATCH Gateway

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The DFVLR introduces the SNATCH software for the equivalent coupling of the Siemens BS2000 plant in Stuttgart with the IBM-SNA network of the other locations. Thus the original problem of creating a computer connection for all five locations of the DFVLR has been solved completely.

The results of the SNATCH project are however of an importance much more than for the DFVLR. During the entire period of the project data processing officials from many public establishments and economic enterprises have visited the main division of the Central Data Processing and obtained information as to how their TRANSDATA and IBM networks can be coupled by means of the SNATCH Gateways. The Siemens AG as partner in cooperation with the DFVLR has decided with regard to the large number of enquiries to take over the SNATCH system in their standard product spectrum. Since the middle of 1983 it has been offered on the market under the product name of TRANSIT-CD.

Since the middle of 1982 the SNATCH/TRANSIT-CD software was installed with the support of the development team also outside the DFVLR. In July, 1983 the following pilot plants had been completed:

- ..DFVLR
- ..Mannheim University
- ..The Federal Criminology Office of Wiesbaden (BKA)
- ..The Computer Association of Konstanz (CGK)
- ..Deutsche Bank Eschborn
- ..Bayer AG Leverkusen
- ..Volvo Sweden

In the companies:

..Daimier Benz AG of Stuttgart
..Datebank Bremische Haefen

installations are also foreseen for the fall of 1983. A series of other companies have announced their interest in SNATCH among others, among others the company Axel Springer Publishing Company, Hamburg and Berlin, Dresdner Bank, Commerzbank, Deutsche Bundesbank, Post and Telecommunications Technology Central Office (PTZ and FTZ), Bosch, Blaupunkt, /82
Deutscher Ring der Bausparkassen, Ortskrankenkassen of Schleswig Holstein, Steyr-Daimier-Puch of Austria.

Because of the great interest of the users Siemens AG signed a contract with the DFVLR for the second semester of 1983 to extend the SNATCH/TRANSIT CD system in a second version in such a way that the terminals can also be connected directly to the Gateway computer. Thus the system can also be introduced economically by users with smaller networks. Another extension of the product is expected.

8.1.5 Evaluation and Prospects

In the SNATCH project it was shown on the example of two important manufacture network architectures, that closed manufacturers' networks can be opened through the Gateway technique. In particular it was proved thus that even the higher processing oriented communications protocols can be converted practically into each other in an image forming computer. So far no comparable systems are known around the world which implement the coupling of networks through Gateways taking into account the higher protocols.

The results of the project were introduced directly into the industry, on one hand in the form of a marketable product, on the other hand as an extensive know-how. Thus the DFVLR has made a concrete contribution to the technology transfer.

The results of the SNATCH project are important because of the rapidly increasing importance of computer networks. Moreover because of the intense market pressure of SNA networks for the German data processing industry (here the Siemens AG), they are under the present point of view of particular significance for market strategy. Now that the Siemens BS2000 computers or entire TRANSDATA networks can be coupled with networks of the market leader by means of the SNATCH, the danger that the BS2000 system would be driven out by systems not manufactured in Germany (and therefore the loss of jobs) has decreased perceptibly.

For the DFVLR the knowledge acquired in the SNATCH project represents the basis for further studies in the area of computer connection and for data communication. Thus for example the participation in the structure /83

of the German Research Network (DFM) is provided. The DFM is a planned open computer connection for research establishments, universities and industry and should make available data communication services for the scientists of the most different disciplines. The main division of the Central Data Processing intends to implement just as for the SNATCH Gateway technique the access to the DFN for Siemens and IBM systems and later in collaboration with the research area of communication technology and exploration of the DFVLR will work out the satellite communication and connection of computer networks of other countries to the DFN.

Parallel to this it is studied how another important manufacturer architecture, the DNA (Digital Network Architecture) of the Digital Equipment Corporation (DEC) can be connected to the SNA and the TRANS-DATA. A functional connection between the systems of these manufacturers is urgently required in the DFVLR to connect the DEC systems operating in large number with the large computer network.

At the international level the contacts to the Chinese Aeronautical Establishment (CAE) and the Indian Space Research Organization (ISRO) are further extended. Both institutions are interested in using the experience of the main division of the Central Data Processing of the DFVLR in joint projects.

8.2 International Collaboration

The DFVLR has been working for a long time in different areas of air and space research with comparable institution of other countries, exchanging scientists and holding workshops in which subjects are discussed which are in the joint interests of individual establishments.

In the area of the operation of universal computers the main division of the Central Data Processing of the DFVLR had made contact with the Indian Space Research Organization (ISRO = Indian Space Research Organization) and in 1981 with the Chinese Aeronautical Organization (CAE = Chinese Aeronautical Establishment) and discussed the areas in which a collaboration is possible. In both cases the working region of the computer network proved to be suitable.

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8.2.1 The Collaboration with ISRO in the DICNET Project

Just like the DFVLR the ISRO is distributed geographically in different locations. In the individual centers systems of the manufacturers CDC, Univac, and DEC (VAX-11) as well as a real time network with IRIS systems are operating. A connection of these systems to a heterogeneous computer network is most desirable for the ISRO quite similarly to the situation for the DFVLR.

The collaboration with ISRO began at the beginning of 1982 with the joint project of DICNET (DFVLR-ISRO Computer Network). In this project the experience acquired on both sides from the operation of computers from different manufacturers and the knowledge obtained from previous computer coupling projects will be used and a software system will be developed which:

- ..allows the ISRO to connect the existing universal computers into a functional connection, while the manufacturers network software DECnet will be used in front end computers of the types PDP-11 or VAX-11 as transport vehicles,
- ..the DFVLR will make possible an access of computers of the type PDP-11 and VAX-11, which are connected through DECnet, on IBM compatible systems in the SNA network.

The functions

- ..transmission of jobs to a target computer and return of job output,
- ..data transfer,
- ..dialogue access in line mode (for IBM also in full screen mode),
- ..intertask communication

will be made possible successively between the heterogeneous systems.

The technical solution provides that as far as possible hardware and software systems available on the market be taken as basis for the transition between the systems of different manufacturers, these are nowadays usually instrument emulators. Because of the DEC systems existing both for the ISRO and for the DFVLR, they will proceed in this connection from the emulators in the DEC computers for IBM, CDC and Univac connections and supplement them by network software developed by themselves so that the DECnet can be used as transport system between two large computers (in the case of the ISRO) or one DEC system and one large computer (in the case of the DFVLR). The communication connection used is first a conventional, ground-bound rented connection (Telex, telephone or suchlike). But from the beginning the software is laid out in such a way that it can also be used for a satellite connection. /85

This pragmatic principle of solution which can be considered as the technical alternative to the Gateway principle of the SNATCH project, was chosen to keep the costs of the development as low as possible. For the case of application for the DFVLR it is planned to introduce the DICNET software which allows a nonsymmetrical access of DEC systems through the IBM large computers as an intermediate stage until it is possible to replace it by the planned symmetrical solution of a DEC/IBM Gateway.

The goal of the projects will be achieved in the following phases:

1. Access to a local or remote universal computer through the devices existing on a process computer
2. Access to a remote universal computer through the devices existing on a universal computer

Moreover the preliminary studies for the subsequent phases provide for:

- ..transmission of mass data through a satellite connection
- ..Gateway solution for the transition between the DECnet and the SNA.

The DICNET project will be completed by the end of 1984. On the Indian side on the average about one and on the German side about 1.5 man years/year will be applied to the joint project. To spread the know-how as widely as possible and to achieve the best possible training, the Indian guests scientists who are collaborating in the project in Oberpfaffenhofen will be replaced every six months. /86

8.2.2. Collaboration with the CAE

In 1981-1982 the Central Data Processing received three guest scientists from the Institute for Computer Procedures of the CAE in Xian, China for study periods of half to one year. The main point of the training lay in the subjects of structure and operation of homogeneous manufacturer specific computer networks (in particular the TRANSDATA of Siemens and the SNA of IBM) and the implementation of a heterogeneous computer connection in the SNATCH project.

Three workers of the main division of Central Data Processing moreover held a two week course on this group of topics in the fall of 1981 in Xian.

The exchange of workers is continued now. A Chinese guest has once again visited for four months the Computer Center of Oberpfaffenhofen to acquire special knowledge in the generation and management of the Siemens TRANSDATA network.

In the fall of this year another group of workers of the Central Data Processing will travel to China to hold a two week course on problems of the operation of computer centers, the computer network and operating systems. Moreover the possibilities of implementing concretely the relationships in the form of joint projects will be discussed.

9.1 Introduction

Up to 1979 the Central Data Processing had restricted itself mainly to the supply of services for the universal computer. Only in the Research Center of Goettingen is there already a direct support of some experiments. Here an on-line measurement data processing was implemented by means of a coupling between the wind tunnels and the on-site computer.

The satisfactory result in Goettingen, but primarily the increasing requirements of the institutes and establishments of the DFVLR for powerful systems for measurement data processing, and specifically not only for the pure evaluation but primarily for the management of large amounts of measurement data, cause the WT sector to take up this specialized area. The Central Data Processing was assigned to the development of a process computer concept and local process computer networks in connection with the overall computer concept of the DFVLR.

The initial situation was just as unsatisfactory as a few years before for the universal computers. In institutes and establishments there were many autonomous process computer plants with the most different operating systems. The consequences were obvious:

- ..unfavorable operating conditions, because there were too many manufacturers;
- ..costly peripheral equipment, because there were autonomous systems
- ..little or inadequately maintained software because of the too high costs of purchase and maintenance for the individual institute;
- ..unprofessional connection of scientific personnel, because each experimenter carries out routine problems of data processing on his process computer (system care, search for defects, among others).

The objective sought by the Central Data Processing was to reduce the costs for process data processing by suitable measures such as:

- ..standardization
- ..central process computer with adequate configuration (location process computer),
- ..process computers at the site of the experiments with minimum configuration,
- ..central care

and simultaneously improving their capacities. To this end a concept was developed in which the considerations of the Central Data Processing, the problem statements and the desires of the users, the developments of hardware and software of the past years and the company policy goals of the DFVLR were included.

9.2 The Process Computer Concept of the WT Sector

The capacities in this concept represent the services provided to the institute and establishments of the DFVLR. The concept contains both central and decentralized elements and is so flexible that it can satisfy the requirements of any research center.

Standardization of the Hardware and Software

The standardization and unification of the hardware and software creates the prerequisites for saving of costs in the establishment and operation (favorable conditions in purchase, central component service, central care for software, framework contracts).

Computer Connection

The access to other, especially central, resources of the local process computer connection allows the reduction to the minimum of the configurations on the site and because of the greater comfort shortens the time for program development. Through the coupling of the on-site process computer-site computers the process computers can have access to all the resources which are connected to the computer network of the DFVLR.

Central Process Computers with Adequate Configuration

The central resources used jointly allow a better utilization. Having the configurations allow the implementation of powerful software products which benefit through the local connection all the operators, especially those with process computers of minimum configuration. /89

Process Computers with Minimum Configuration on the Site

By using standard workplaces with minimum configuration (including the interfaces) investment and maintenance costs are reduced and planning and implementation times shortened.

Central Care

The central care relieves the operator of the process data processing unit from the implementation and maintenance of the operating system and

system components, offers them a widely assorted user support and gives them thus more time for their own reserach problems.

Figure 13 shows the hardware structure of the process computer concept and indicates clearly the relation with the computer concept of the DFVLR.

Function Description of the On-Site Process Computer (SPR)

The on-site process computers have the following functions:

- ..support of the software development of the terminal of the process data processing workplace (PDA)
- ..extensive "quick-look" calculations and their presentation on the PDA through simple "graphic periphery"
- ..on-line process data processing (reduction) for large computers
- ..special evaluations (for example real time) which cannot be carried out on the on-site computers
- ..powerful software products
- ..mass storages for PDA
- ..powerful periphery for PDA (for example fast printer, fast plotter)
- ..testing of new software components.

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Moreover these systems are taken for training and instructing the users in the area of process data processing.

The basic equipment of the on-site process computers include working storages, plate storages, magnetic tapes, fast printers and plotters. The system software includes multi-user operating systems, combined with suitable network software. The further equipment is set up according to the requirements of the users in the research centers.

Functional Description of the Process Data Processing Workplaces (PDA)

The process data processing workplace is the connecting element between the computer system on one hand and the process or user on the other. The "computer system" can be any component which can be connected with the PDA through the computer network. The functions of the PDA are derived from this:

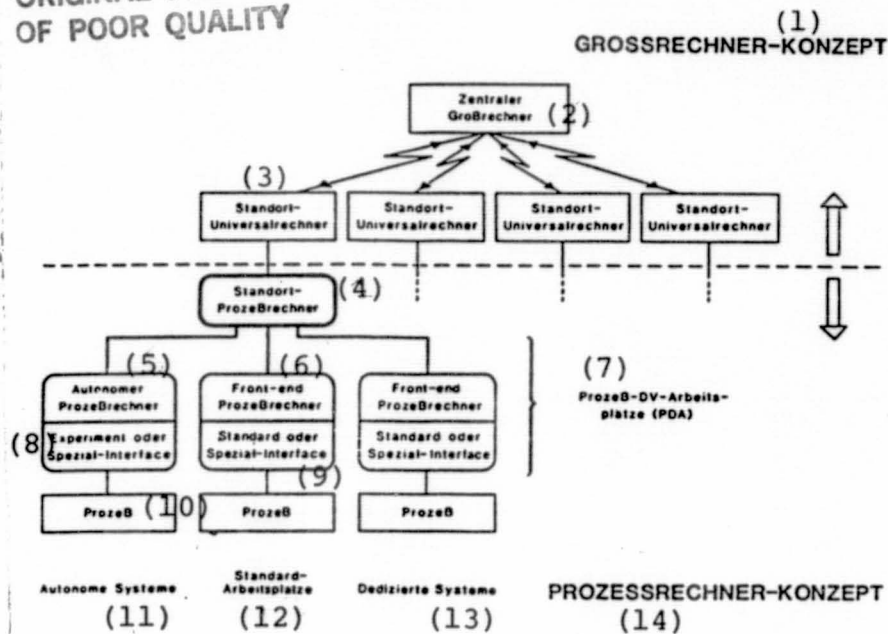


Figure 13: Structure of the process computer concept of the DFVLR.

Key: (1) large computer complex; (2) central large computer; (3) on-site universal computer; (4) on-site process computer; (5) autonomous process computer; (6) front-end process computer; (7) process data processing workplace (PDA); (8) experiment or special interface; (9) standard or special interface; (10) process; (11) autonomous systems; (12) standard systems; (13) dedicated systems; (14) process computer concept.

- ..control of the process interfaces for the process data recording and process control in real time including quick-look,
- ..connecting element between process interface and on-site process computer,
- ..data preparation and data reduction,
- ..real time tests on the experiment.

The equipment of the process data processing workplace is arranged according to the requirements of the process period. Workplaces can be autonomous systems, on-site workplaces or dedicated systems. If the interfaces to the process are standard interfaces, they are made available by the Central Data Processing; if they are special interfaces, then the main division of Applied Data Technology is the responsible section.

Central Care and User Support

The Central Data Processing provides for its users the experience and the knowledge their workers have acquired in handling complex systems. The care includes among others the implementation and maintenance of operating systems and system components. The user support includes a broad spectrum of services:

..Planning

Establishment and extension of existing on-site concepts (on-site process computers, process data processing workplaces and local networks) within the framework of the business order for the data processing commissions in the DFVLR.

..Training

Courses on system and network software, languages, process data processing.

..Advice

In the application of system and network software as well as the available software products in problem analysis and in the search for defects.

..Development

Of software close to the system, user programs with general possibilities of application and user compatible procedures.

..Interface adjustment

..Collaboration on plans and projects.

An important prerequisite for an effective user support by the Central Data Processing is constant talking with the users. But close collaboration with other establishments of the DFVLR, which are working on the problems of process data processing is almost as important. This includes mainly the main division of applied data technology (WT-DA) which yields with the concept, specifications and implementations of dedicated process computer systems.

The main element of the work of the WT-DA lies in this connection in the development of special interfaces and their embedding in a standard-PDP11 environment (hardware, firmware, operating system expansion), system aspects such as high availability and reliability, easy possibility of modification, extension, high data flow, extreme conditions of use etc. play an important role in this connection. The WT-DA takes over the maintenance of all the products which they have developed.

9.3 Implementation of the Concept

In spite of the urgent personal bottlenecks in the main division of Central Data Processing during the last five years it was possible to

set up on four of the five DFVLR sites process-data processing groups. The workers in these groups cover, apart from the site specific characteristics, the entire range of services foreseeable in the concept. Most of the establishments depend on these four sectors. The inquiries are increasing meanwhile faster than WT-DV can provide the resources needed for covering the needs. The extension achieved in the individual areas is described below:

Braunschweig

In 1981 the central on-site process computer, a VAX 750 was installed under VMS. In planning it the WT-DV had started from the fact that the requirement in this area would not develop as quickly as in the others, since a large number of well set up autonomous process computer systems exist in the institutes. The further development soon showed that the supplies were accepted very well. Within a short time already 11 experimental computers had been connected in the institutes through Mininet:

- ..design aerodynamics
- ..flight control
- ..flight mechanics
- ..structural mechanics
- ..wind tunnel

Particular interest was aroused by a process interface laboratory system (PILS) developed in the computer center of Braunschweig on Q-bus basis as a process data processing working place and which offers the users an economic entrance (10,000 DM) to process data processing with access to all the resources to the local connection.

The connection of four more experimental computers is required by the users, but cannot be implemented now because the capacity of the mass memory is not sufficient. /94

Goettingen

The Goettingen Center received in 1972 a VAX 780 as a new central on-site process computer. Previously a local connection had already been established in Goettingen with three PDP-11 units. Meanwhile 11 experimental computers with the DECnet as network software in the Institute of Aeroelasticity Experimental Flow Mechanics and Wind Tunnels.

The shift of the last applications still depending on the PDP-11 plants, the turning of the transversal tunnel and the three meter tunnel by the site computer and the connection of a process computer in the Institute for Aeroelasticity through Ethernet through the site process computer VAX 780.

As an example for an application in the integrated large computer process computer concept we may mention here the expandable adaptive speed course of the Institute for Experimental Flow Mechanics. The regulation and data recording of this experiment should take place on the site, the very extensive evaluation required for the adjustment of the tunnel walls on the site computer and data transmission between site computer and site process computer through the IBM/7 system with the coupling software developed in Goettingen.

Koeln-Porz

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The Center of Koeln-Porz was the first area to receive in 1979 a central process computer. A PDP 11/60 was created on which the RSX-11M is implemented as operating system. Since this computer could no longer satisfy the increasing needs, in 1981 a VAX 780 was procured as a second central process computer, operating under VMS.

So far 19 experimental computers have been coupled to these two plants with Mininet in the Institutes of:

- ..Drive Technology
- ..Flight Medicine
- ..Space Simulation
- ..Space Lab Simulator
- ..Materials Research
- ..Central Technical Services.

The connection of 11 more process computers through Mininet as well as the establishment of a fast data transmission between the computer center and the Space Lab's simulator through Ethernet is under preparation.

Stuttgart

The Stuttgart Center received its central process computer, a PDP11-44 under RSX-11M in 1981. A local Mininet connection has been established with it as anode, to which by now seven process and table computers have been connected.

The local Stuttgart connection is a special case inasmuch as it does not support only experimental process computers. The main portion of the planned extensions will not consist of the process data processing workplaces in the sense of the process computer concept, but of micro-computers and personal computers with special emphasis on graphic applications.

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Activities Encompassing the Site

The activities described in the previous sections in the area of process data processing concern local applications. The Central Data Processing is also very busy implementing in stages the catalogue presented in the process consumer concept of essential problems affecting the area. These include providing information to the users through the sites, the coordination of the training and support affecting the site as well as the establishment of better boundary conditions for process data processing through general regulations and contracts.

A first step on this path to an exchange of information affecting the site was the introduction of a communication series. It addresses directly the users of process computers for the purpose of preventing parallel development and wrong supplies. In the first issue the process data processing workplace PILS was described which was developed in the Braunschweig Computer Center (RZB).

Another example for activities affecting the area is the signing of a maintenance agreement for software with the company Digital Equipment Corporation (DEC). This contract regulates for 120 process computers installed in the DFVLR the use under license of operating systems, compilers and network software which assure the regular supply with all corrections of defects, assuring all the new program variants and with documentations. The users are entitled on the basis of this contract to obtain the telephone support by the DEC.

Because of the large number of data processing plants which are included in this agreement, much more favorable contract conditions could be negotiated with the manufacturer than would have been possible with individual agreements.

9.4 Prospects

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The last larger local problem in the next years is the formation of a process data processing group, the establishment of a central process computer and the structure of the local network in Oberpfaffenhofen. These measures connecting the personnel and means should naturally under no circumstances lead to blocking the further work at the other four sites. After the institutes have set to work with their experimental computers as a function of the WT, besides the continuity, the constant adjustment to the user needs must be assured within the framework of the WT process computer concept.

Among the problems affecting the site in the next few years we should mention primarily the fast coupling between the site computers and the site process computers. The Central Data Processing is planning on a short-term basis the Goettinger/7 solution as transition solution (speed

of transmission 10 KB/sec) in the centers of Braunschweig and Koeln-Porz. For a medium-term systems are planned with higher transmission speed (100 KB/sec). Market studies have already taken place in this area.

A second essential problem is the further extension of the local networks. In three areas so far only the very economical but also very slow Mininet network (9,600 bauds) have been installed, whose transmission speed is not sufficient for a number of applications. In planning faster process computer couplings care must be taken that there should be no incompatibilities with the LAN (Local Area Networks).

In the sector of the framework agreement after signing the software maintenance agreement with the company DEC now the signing of similar agreements with other software suppliers has started. Moreover the establishment of framework contracts for the hardware maintenance in favorable conditions must be promoted.

10. Text Processing and Office Automation

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The text processing had been for a long time the stepchild of automated data processing. Only in a few special applications, for example in documentation (information retrieval) in text analysis (literature and theology) or in book and newspaper printing had it been introduced and improved to an extent worth mentioning.

With the appearance of microelectronics and the development of new memory technologies this situation has changed drastically within a few years. Vast computers in all sizes, economical mass memories and powerful networks are the components by means of which today many problems from the extensive sector of nondigital data processing can be solved better and more economically than before.

The purpose of the computer supported text processing is to improve communications. For texts are carriers of information and therefore means for communication. The communication is improved if:

- ..the texts are more legible
- ..their content is prepared better
- ..they achieve their goal faster and more reliably
- ..they can be recovered and available at any time.

The automation of text processing and support by data processing systems is much more than the attempt to replace typewriters in secretariats by display screens or costly personal computers. It is more than what is now described to users as the latest discovery under the fashionable word "office automation". The diagram shows which tasks should be classified under the concept of text processing:

Table 5: Operations of Text Processing

Processing Texts

| preparation or organization | managing or making available | transmission | producing con- texts and processing |
|--------------------------------|---------------------------------|---------------|--|
| input | deposit | transmission | indexing |
| editing | archives | communication | cataloguing |
| formatting | retrieval | | |
| output | term monitoring | | |

Computer supported text processing is thus an aid with which the exponentially growing flow of data can be managed better. Just like any data processing system it can be introduced wherever the work and progress can be described by algorithms and therefore be converted into programs. Text organization (formatting) and office automation are only two partial regions of this extensive new area of application of data processing.

10.1 Text Processing in the DFVLR

The DFVLR as a research organization "produces" information. It gives information outside and requires information from outside, to be able to operate. It gives out continuously, this is a great portion of its daily activity, information internally and processes it (converts it). Texts are the medium which make information available. Text processing is therefore a central element of the work of the DFVLR. It covers the wide region of the simple correspondence through documentation and reporting up to the information consolidation in information retrieval or in information systems.

The object of the task "text processing" include therefore not only /100 writing systems, formatting programs, text editors, input and output equipment such as display screens, high power printers or cheap printers at the work job, but rather include the topics of text management, organization, preparation for use and text transport. But this would include as elements of this comprehensive working region also such problems as data banks and interrogations, management support, documentation systems, reports, office organization among others.

The Central Data Processing has started three points important for the DFVLR to work out the new and extensive sector of text processing:

- ..the organization (editing and formatting) of texts,
- ..the management and transmission of data in the office sector (secretariates) and
- ..the indexing and retrieval of text (documentation system for library science and inquiry systems for different areas of use).

Standard solutions such as are already offered on the market are not always applicable for the DFVLR. Two primary obstacles stand in the way of the use of such "off the rack" systems:

1. The finished products solve specifically partial problems for certain areas or cases of application, but are incompatible with other applications. They lead to "island solutions" which later seriously prevent cooperation in the DFVLR.
2. The requirements in the DFVLR are so diversified that they cannot be satisfied or not satisfactorily satisfied with the systems which are now offered on the market.

Both statements apply very particularly for systems which so far have been supplied or are to be supplied on the market for text organization and text processing (formatting and typing systems).

10.2 Text Organization and Text Preparation

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The organization of the text is the establishment of the external appearance (setting, layout) of a document. It begins with the input of the text into a data carrier (paper, magnetic layer, display screen with connector computer or memory, etc.), continues with all possible types of modification, extension, improvement, editing of the contents and the form of the text and ends with the output of the written document on an output medium.

Text preparation includes all the activities with which the transmission and handling of the text can be improved and its comprehensibility improved. In particular this includes all the forms of consolidation and selection of data contained in the text. The establishment of contents, subject registers, references, catalogues, summaries, translations, etc. are therefore part of text preparation.

In the DFVLR the daily activities include very different types of documents: internal and external correspondence, scientific publication of all type, documentation (descriptions of objects, project accompanying protocols), descriptions for publicity work, etc. The requirements which are imposed by these different types of texts are very different. Nevertheless in many cases several workers often from different areas (establishments, research centers) and with very different types of

training. An example of this would be:

- ..text input by a typist,
- ..editing by a technical worker,
- ..correction, modification and processing of the content by the scientific worker.

Such working with distributed tasks is only possible when all those involved can have direct access to the text and when the systems with which the text is processed are compatible with each other. The Central Data Processing has therefore from the beginning kept its eye on a solution in which the existing data processing systems (universal computer or site process computer with display screens in dialogue operation) play a leading role in the functional units and the existing computer networks /102 act as transport means.

10.3 The Text Processing Generalized Markup Language

The text processing system GML (generalized markup language) which is being designed and implemented in the Central Data Processing, is based on the formatting system DCS (Document Compensation Facility) of the IBM. The functions which are offered by this formatting system are indeed considerable but not applicable without special training. Specifically they give the user almost total freedom in the organization of his text, but require from him knowledge which come close to those of a typesetter in a printing press.

Moreover the user when working with the formatting system of the DCF must always take into consideration the properties of the output instrument on which the text is to be established. A transition to another output instrument is equivalent to a new formatting of the entire text.

The area of application of such a system designed for specialists is therefore very limited. A system which can be used by all the establishments of the DFVLR and which should improve the collaboration between typists, officials in charge and scientific authors, must therefore satisfy other requirements.

The user interface of such a generally applicable system must from the beginning be laid out in such a way that it is just as acceptable to the authors who as a rule are familiar with the techniques and procedure of data processing and by the actual "writers", the secretaries and typists, to whom the methods and instruments of data processing are mostly unknown.

From the general goal of designing a system which would be applicable for many areas of text organization and processing, a series of requirements were derived directly for the performance and design of this system:

- ..The structure of the simplest possible number of standard instructions, with which all the types of texts used in the DFVLR (manuscripts) can easily be described and organized;
- ..Installation of a user interface in such a way that the typist and authors can use the standard instructions almost without training and therefore can organize the text;
- ..Supplementing of the instructions by functions which facilitate the processing of the documents (establishment of list of contents, registers, references, among others);
- ..Establishment of the text system in such a way that the properties of the input and output concern the user only when he wants to use them;
- ..Possibility of access to the system and to the text to be processed by all research centers;
- ..Adjustment and current extension of the system according to the extent of the development of hardware and software supplied on the market and to the changing and increasing requirements of the DFVLR.

The Central Data Processing has found with the text processing system GML a solution principle which satisfies these requirements. Its principle is simple:

the user does not organize the text, but indicates the text elements of which his text consists (headings, paragraphs, figures, tables, citations, etc.). The GML text system feeds these data into the actual setting instructions for text organization (layout) and takes into consideration in this connection the properties of the output instrument or the special data of the user for the output form (design, book setting, typed forms, among others).

With this principle the user is released from all considerations of page size, distance of lines, line length according to the size of the page, form of type and setting level, pagination, figure counting and suchlike. The conversion of the "text description" into such setting instructions can be automated and is therefore taken over totally by the GML. The work for the user is therefore much simpler and clearer. /105

The first edition of the GML text processing system was handed over at the end of 1982 to the users of the DFVLR, the second highly expanded edition in August, 1983. Up to now GML is supporting the outlet equipments of display screen, line printer and laser printer for printed documents including the capacity for photosetting. The most important functions of the GML are:

- ..Organization of any text by means of a few simple characteristics (marks),
- ..Independence of the marks on the choice of the output equipment, therefore simple transition from one form of output to the other,
- ..Automatic counting of section and pages,
- ..Automatic establishment of the table of contents and lists of figures,
- ..Computer supported establishment of special registers,
- ..Automated reference technology for footnotes, figures and headings,
- ..Automatic syllable separation and spelling control in German and English.

10.4 Continuing Work and Prospects

GML is thus supporting already in its present form the text processing in important points. For the further development the essential points are those where in the DFVLR particularly urgent requirements exist for text processing and economical solution seems to be promising with the software and hardware existing or to be expected on the market. These include in the near future (compare also section 3).

- many column text arrangement and organization of tables,
- formula writing, possibly collaboration with other text systems specially developed for this purpose, such as for example TEX,
- mixing of graphs and text,
- extension of the range of outlet instruments, especially outlet at the workplace and
- document management and composition of texts (standard texts). /105

The last point already corresponds to the transition to the longer term and more comprehensive task of office automation, documentation and information retrieval and therefore creates a bridge for the further goal of preparing for the DFVLR a powerful information system in all areas.

11.1 Introduction

The evaluation of numbers requires time. A graphic representation shows immediately the essential elements. Decisions come easier when the data occur in a clear form. The graphic data processing as a preferred instrument for the quick interpretation of data is also for the future an important working sector of the Central Data Processing. In the years between 1969 and 1976 the requirements for graphic output for the users has been increasing constantly. In all computer centers graphic equipment, including graphic visual equipment has been provided by Benson, Calcomp, IMLAC, Tektronix and Vectorgeneral.

This diversity of instruments from different manufacturers and of different types corresponds to just as great a diversity as regards software. Each manufacturer delivered its own basic software, which mostly did not satisfy the requirements of the users of the DFVLR in all their functions. Moreover it was a very complicated and time consuming matter to introduce them. Here aids had to be provided.

11.2 New Statement of the Problem

The Central Data Processing set itself as a goal the introduction of a new graphic base system as the basis for a uniform graphic software for all five sites. It was necessary that this software:

- ..should be implemented for all computers of the network,
- ..should be able to serve the different graphic output instruments,
- ..should allow interaction works and
- ..be compatible with the previous programs without much program modifications.

These criteria and the desire of the user to be able to work out and /107 give out with the same language their graphic problems independently of the type of outlet instrument at all sites and computers, led to a market study of the graphic software offered at that time. The graphic core system GKS, which is today the standard according to the DIN (Federal German Standard Organization) for graphic basic software was then still in the development stage. At the beginning of 1978 the main division of the computer center decided to create the GINO-F base system. This system was then the English proposal for a European standard. GINO-F (Graphical Input/Output FORTRAN Version) was developed by the Computer Aided Design Center (CADC) of the Cambridge University and marketed by the companies AGS and TEWIDATA.

In 1978 GINO-F was implemented in Goettingen and Oberpfaffenhofen under the IBM operating system in Stuttgart, Braunschweig and Koeln-Porz under the Siemens operating system. Since especially for the Siemens

BS2000 system the Tewidata Company could supply no support in the implementation, the Recheninstitut for das Bauwesen (RIB = Computer Institute for Architecture) was entrusted with this. The RIB took a decisive part in the further developments of the graphic software on the basis of GINO-F for the DFVLR.

To avoid double work, to speed up the development work and to coordinate the graphic activities in the individual research centers, in 1979 the Graphic Special Group was formed. In each site, one or two workers were trained especially for graphic work.

At the end of 1982 it was possible for the users in all areas of the DFVLR to have the second variant of the graphic software on the GINO-F base. Thus the DFVLR has received a stable and reliable tool, which will cover a great share of the requirements even in the years to come.

As a further standard supply in all areas the Calcomp Software or the "American Standard" Software is available. This is necessary and important primarily for two reasons:

- ..It provides continuously programs which are purchased from the outside and established on the Calcomp Software.
- ..It should also be possible to transmit to the exterior the program developed in the DFVLR with graphic software.

11.3 The Graphic System GINO-F

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GINO-F is a software system with which bidimensional and tridimensional objects can be reproduced in the bidimensional space.

A criterion for GINO was and is that the system can operate all the important graphic instruments with a user interface. This requirement is opposed by the strict modular form of the GINO-F system and the fact that almost the entire system is programmed in FORTRAN-IV and the instrument drivers are all operated through a single interface.

The basic software of the GINO-F system has three levels:

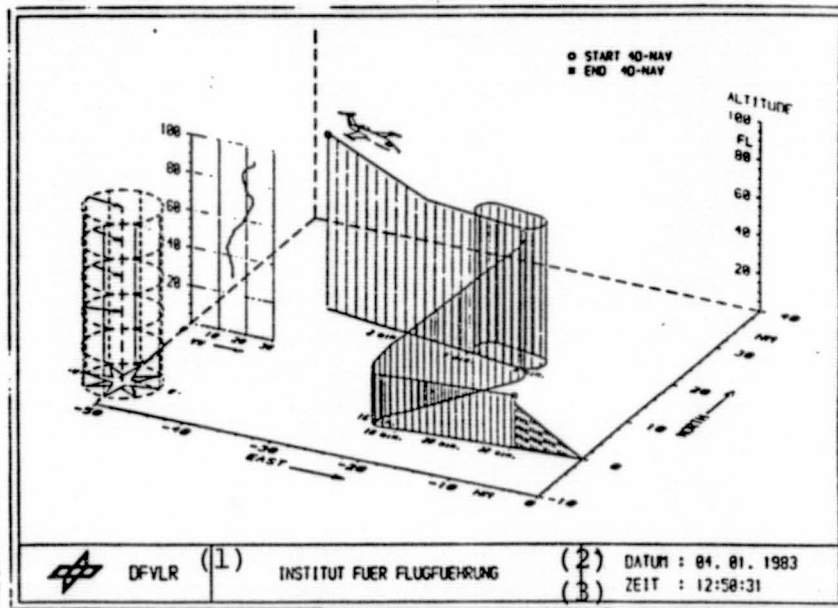
1. the back ends which produce or process the control codes independent of the equipment ("pseudocode") for the graphic input and output instruments;
2. internal GINO-F routine;
3. the user interface of the GINO-F base software.

This use interface contains the following functional groups for:

- ..Control functions,
- ..Drawing of lines,

- ..Switches for line drawing,
- ..Character and symbol output;
- ..Switch for character output;
- ..Conversion in different systems of coordinates;
- ..Graphic input;
- ..Interrogation.

Besides this there are always a series of auxiliary routines, such as for example the calculation of text lengths, positioning of texts, conversion of coordinates among others (Figure 14).



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Figure 14: Tridimensional representation of different diagrams in one graph with adjusted writing. Key: (1) Institute for Flight Control; (2) date; (3) time.

11.4 The Plot Processor

One of the special properties of GINO is the production of a code (pseudocode) independent of the equipment. Its advantages are however felt completely only by using a "postprocessor" for the interactive processing of the stored graphic information. In the DFVLR the interactive "finishing" unit is called plot processor. The plot processor was developed by the RIB in collaboration with the workers of the "Graphic Special Group". It uses as input the segmented GINO-F pseudocode established by the user and has the following function:

- ..Finishing of figure data set on an interactive graphic display screen with diversified functions;

..Finishing of image data sets on an alphanumerical display screen for output on plotters.

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Thus the user has many possibilities of forming images, such as amplifiers, reducers, rotation, choice of any sections, displacement, composition of segments, output in another image data file or on any plotter of the DFVLR with free selection of number and scale, "quick-look" of segments of image data filed among others.

Many of these functions can also be carried out on a nongraphic display screen. The graphic output in this case is still on a plotter.

The operation of a plot processor is the same for all operating systems, except for such commands and procedures which address directly the operating systems.

11.5 Embedding of the Graphic Software into the Computer Network of the DFVLR

GINO-F was adjusted by the workers of the "Graphic" Special Group in such a way to the operating systems of the IBM (MVS/TSO and VM/CMS) and Siemens (BS2000) that the user can exchange his graph program without alterations between these operating systems. The user interface of the interactor plot processor is identical for all operating systems. Moreover the graph software is fully operated in the computer network of the DFVLR. If the graphic output of a job is to be transferred to another computer in the network, the user has only to indicate the site and the plotter (for plot output) or the data file to which the output has to be transferred. The pseudocode is also used for transmission and reception.

Through the computer network of the DFVLR thus different types of communications are possible:

- ..The graphic output can be transmitted from any computer to any other computer of the DFVLR network and then the process interactively there or immediately given out on the computer.
- ..Thus the user can calculate the jobs with intensive computation on the IBM 3081, but transmit the graphic output to a plotter in Koeln, Braunschweig, Goettingen or Stuttgart.
- ..Interactive graphic instruments on the MVS and VM plants can reach IBM computers in the other areas.
- ..Interactive instruments on Siemens plants can be operated only with their own host. This implementation is eliminated with SNATCH.

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11.6 Additional Software Compatible With the User

An official problem in the introduction of GINO-F was that already many user programs were available on all the sites with subprograms for the Calcomp, Benson and CIL plotters. In order that the users should also be able to use unchanged these programs and still enjoy the advantages of GINO and the plot processor, the Central Data Processing developed simulation programs for GINO. This simulation software is used not only to manage the "old world". Programs which come from outside or must be transmitted to the exterior, often contain Calcomp software. These will also be processed in future with the simulation software.

At the same time as the studies on the basic software the special Graphics Group has started to develop a user software packet called ZUGINO which has constantly been extended since then. This packet contains primarily user compatible routines for the following functions:

- ..Representation of linearly and logarithmically divided coordinated axes,
- ..Representation of functions of a variable in plane cartesian systems of coordinates with many possibilities of control for diagram forms, types of scaling, interpolation and curve characterization. Figures can be produced with or without standard frames. /112
- ..Similar possibilities are offered for polar coordinates.
- ..Representation of ISO lines of functions of two variables likewise with manifold possibilities of control.
- ..Tridimensional representation of functions of two variables with the possibility of choosing the type of project, rotation, scaling and suppression of nonvisible lines (hidden lines).

Figures 14 and 15 are examples of such representations from the scientific work of the DFVLR.

For some time now the administrative users have also announced their wishes, primarily for a presentation graph. ZUGINO offers today two possibilities for this purpose:

- ..Representation of high charts with different shaded sectors and inscriptions.
- ..Drawing of histograms (bar charts) in different types of representation.

Figure 16 gives two examples of this.

But the present convenience for graphic data processing is no longer sufficient for this new group of users. All that has been supplied so far is intended for incorporation in the existing user programs or for programs to be newly written. But this implies programming knowledge which does not always exist among some groups of users. Therefore they started offering user programs which the user can apply already when he only knows how the display screen and editing device are operated. For this procedure there is already a program packet for presentation graph (ICU) and an interactive graphic editing device (GRISLI).

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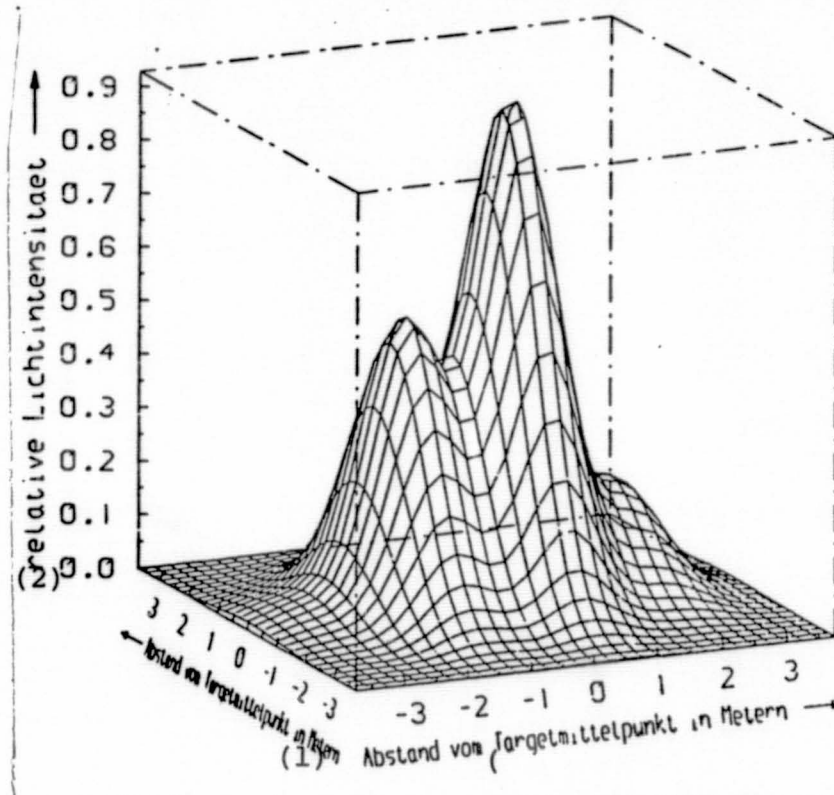


Figure 15: Tridimensional representation of a function of two variables with suppressed nonvisible edges. Key: (1) distance from the target center in meters; (2) relative luminous intensity.

11.7 Continuing Works and Prospects

The development in the hardware sector is still in full progress for the graphs also and will lead in the coming years to a better cost/performance ratio for plotters and terminals. Graphic software based on the GINO-F is today the standard supply of the main division of the Central Data Processing to its users. Therefore work is still needed for rounding off the supply in several regions:

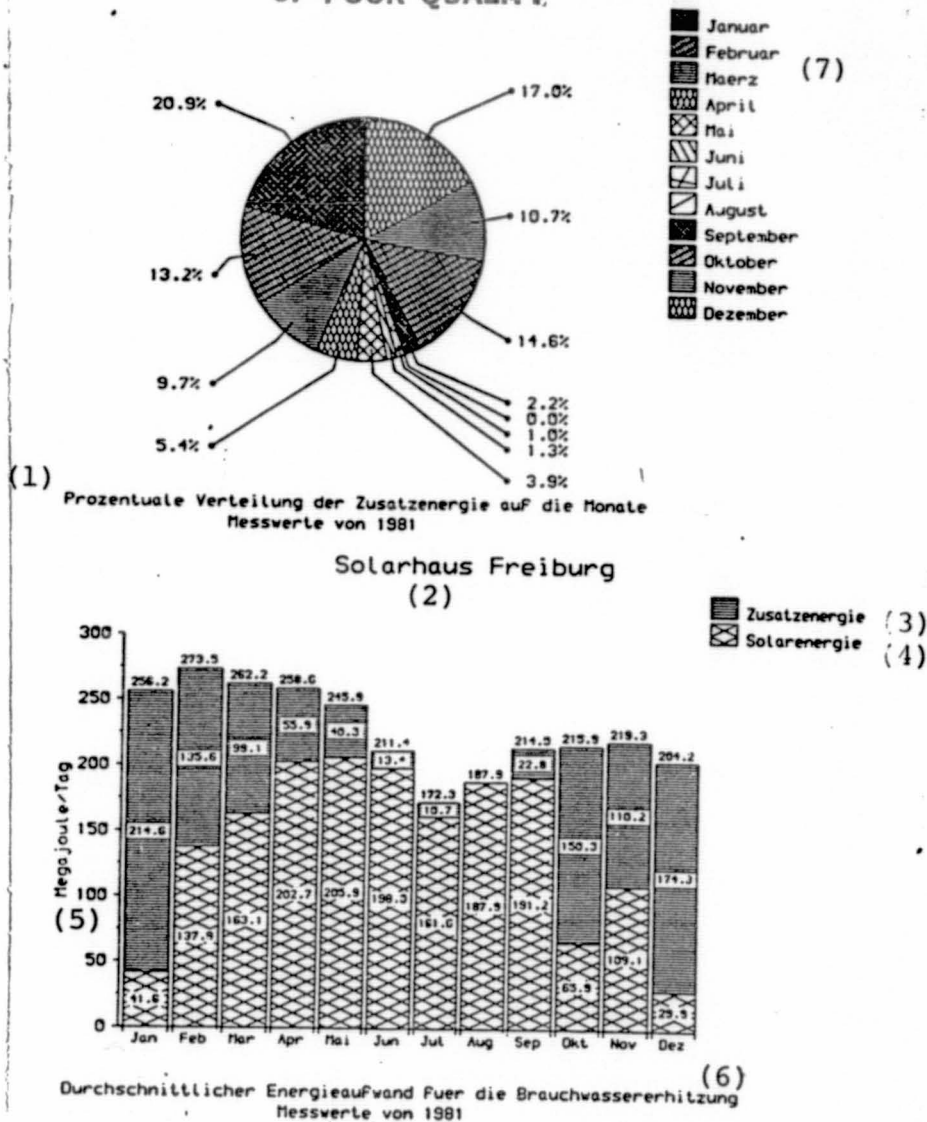


Figure 16: Examples for different forms of presentation graphs in the user software ZUGINO. Key: (1) percentage distribution of additional energy over the months measurement values of 1981; (2) Freiburg Solar House; (3) additional energy; (4) solar energy; (5) megajoules/day; (6) average energy consumption for heating water for industrial purposes measurement values of 1981; (7) January, February, March, April, May, June, July, August, September, October, November, December.

..Backends for more new graphic hardware

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- extension of the graphic workplace with tray and many color plotters.
- high resolution color scanning terminal.
- hard copy for color terminal.
- graph on COM systems (microfilm plotter).
- graph on text system (laser-printer/plotter).
- graph on microcomputers (dedicated graphic systems).

..Improvement of user compatible software for tridimensional representation

..CAD/CAM applications

..Preprocesses and postprocesses for finite element programs

..Algorithms for raster graphs.

Moreover the graph software must be made available for new computers which are installed in the DFVLR. These include primarily the process computers and to an increasing extent also the personal computers.

Difficulties arise now for the transmission of programs which are written in GINO-F to external centers. GINO-F has not spread as far as was expected. Thus the transferrability of programs with GINO parts is very limited. The DIN (Federal German Standard Institute) Commission for the GKS has retired the metafile concept, a GINO driver will be established who will be able to write and read GKS metal files. Then it will be possible to exchange picture data with all GKS installations.

12. High Power Computers

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In the second half of 1982 the DFVLR procured a vector computer of the type Cray-1S for the users who could not work out their digital large-scale applications on a universal computer with compatible computer times. The Cray computer is connected through adjusted coupling soft and hardware with the IBM 3081 in Overpfaffenhofen and thus accessible to all research centers of the DFVLR through the DFVLR computer network. After its installation in March and the release to the users in June 1983 the Cray computer will be used to an equal extent by the DFVLR and by the Cray Company.

12.1 High Power Computers

Besides the technical progress by faster circuits, faster memories and favorable geometrical arrangement of the computer components with regard to each other, through which the power of the computers was and is improved considerably, besides the progress in the large-scale integration of the electronic components, which had and still has a decisive importance for the improvement of the cost/effect ratio computers, through the considerations on the computer and architecture and the operational scheme, detectable improvements in the computer capacity have been achieved.

The sequential von-Neumann principle of computer structure has survived from the first days of computer development until our time with certain modifications. In this connection besides the significant fact especially in times of higher hardware costs, that the von-Neumann principle is a principle of minimum hardware costs, the great flexibility of this principle was decisive.

After the hardware costs had decreased drastically, another means had been offered to obtain higher computer capacities. It was feasible technically and economically to give up the von-Neumann principle of the universal computer and to introduce for special problems automatic computer units with entirely different architectures and operational schemes. As a concept this was already done by John von-Neumann himself through his considerations on the cellular machines. The purpose of these considerations was, and still is today, to obtain properties which are inherent to the solution algorithms for certain types of problems, such as for example precisely the parallel nature of the processes, the structure of the computer system and thus possibly higher computer power. /117

The milestones of this are:

..the ILLIAC III and IV of the University of Illinois, built by the Burroughs Company,

..the CDC 6600 and the STAR 100 of the Control Data Company.

Among the super computers and array processes which are today on the market, several types can be differentiated.

Multiprocessor Systems

ICL and Goodyear

The only two commercially obtainable systems which correspond to the designation of many processor system are the DAP from the ICL with 64 by 64 and the MPP from Goodyear with 128 by 128 bit series processors. Both processor systems are arranged in a matrix, have direct communication to their four neighbors and are subject to a superior control.

Denelcor - HEP

The HEP is a MIMD multiprocessor computer system of the "shared resource" type. Up to 16 processors can be connected with up to 128 data modules through a multistage network with a maximum flow rate of 10 Mwords/sec per PEM (PEM = process execution module).

This concept may include processors with their own memories and their own computer works, which as a rule work out subprograms of a main program running on the host computer, while among others a not inconsiderable portion of the time is consumed in the transfer of data between the host and the AP. As a rule they operate according to an assembly band principle on the instruction level and each have an addition and multiplication unit, which can operate simultaneously. Computers of this type generally have their place as special processors for dedicated tasks (for example as FFT processor) and are under this aspect an economical alternative, so naturally also with lower capacity for a more universal high power computer.

The most famous manufacturer of array processors of this type is the company Floating Point Systems (FPS). The latter has recently also been offering an AP in which complete programs, naturally without multi-program operation, can be worked out.

Vector Computer

This type includes computers which submit the flows from the operands ("vectors") according to the assembly line principle to the same type of operations, while the operation to be accomplished is divided into segments of microoperations. At present three computers based on this operating principle are obtainable on the market: Cray-1/1S, Cyber 205 and Hitachi S9/IAP.

Cyber 205

The Cyber 205 is (just like its predecessors STAR 100 and Cyber 203) a vector computer with a scalar and a vector part, which can both operate in an overlapping manner. According to the number of conveyors (2-pipe or a 4-pipe version) two or four results are produced per cycle (cycle time 20 ns).

Hitachi S9/IAP

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The Hitachi S9 is a scalar computer with a standard and a high speed computer unit (HSA). Its set of instructions is compatible with IBM/370. The integrated array processor (IAP) is integrated in the sense that the main memory and HSA are used together with the S9. A doubly precise result is produced every two cycles (cycle time 30 ns).

12.2 Applications for High Power Computers

High power computers are used around the world in different areas of applications:

- ..Calculations for the layout of nuclear power stations,
- ..Discovery of natural oil deposits by evaluation of the measurement data of seismic experiments,
- ..Processing of image data, from remote exploration to computer animation,
- ..Structural mechanical studies by means of finite-element systems,
- ..Digital simulation of flow processes,
- ..Weather forecasting.

A large number of these areas of application also play a great role in the work of the DSVLR:

- ..The time dependent calculation of field solutions for tridimensional flows affected by friction for large Reynolds numbers, especially the study of the phenomena of detachment, is a problem requiring an extraordinary intense computation, for which even when using high power computers of the present generation only partial answers may be achieved. An essential goal of these activities is to be able to estimate more exactly the effect of the design parameters on the aerodynamic behavior of a flight configuration. /120
- ..In the digital simulation of combustion processes in the power units, besides the flow physical systems of differential equations the chemical equations of reactions decisive for combustion must be processed.
- ..Study of problems with intensive computation for the structural mechanics in particular of geometrical nonlinearities and elasto-plastic processes.
- ..Problems of the adjustment of mathematical models dependent on parameters to measurement data as they occur in flight mechanics.
- ..Study of physical processes in the atmosphere.
- ..Digital filtering of mass signals, for example in image processing.

12.3 Selection of the Computer

Since the end of 1978 the DFVLR has started dealing with the possibilities of dealing with a high power computer. The encouragement to such considerations came from NASA where investigations on a large scale are being carried out for the requirements of a "numerical simulation facility" as an aerodynamic design instrument. In many seminars

and manufacturer presentations, a survey was given of computer concepts, of high power computers which are available on the market and on the applications in the DFVLR. Since the end of 1979 in collaboration with the flow mechanics sector test calculations on different computers of this type have been carried out:

| | |
|----------------|------------------------|
| STAR 100 | November 1979 |
| CYBER 203 | November 1979 and 1980 |
| AMDAHL 470/V6 | December 1979 |
| CRAY-1 | February 1980 |
| CYBER 205 | November 1980 |
| CRAY 1S | November 1980 |
| CYBER 76 | June 1981 |
| ICL-2960/DAP | September 1981 |
| HITACHI S9/LAP | April 1982 |
| DENELCOR HEP | April 1982 |
| IBM 3081D | May 1982 |

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Under the aspects:

- ..of performance,
- ..maturity of the product,
- ..introduction against existing computer background,

it was possible to consider more closely only the Cray-1 and Cyber 205 systems among the high power computers.

Although for highly vectorizable problems with great vector length the Cyber 205 is more powerful than the Cray-1, the choice could be made only for the Cray-1 because of the criteria of transferrability and user compatibility particularly important for the DFVLR.

Cray-1 and Cray-1S

The Cray-1 is an integrated scalar/vector machine. Here integrated means that the scalar and vector parts use jointly the functional units for sliding, arithmetic. There are 12 functional units in the Cray-1 (13 for the Cray-1S) exactly one for each type of function. One feature of the Cray architecture is represented by the eight vector registers, each of which can record 64 words. Vector operations take their operands as a rule from vector registers and deposit their results in vector registers. If more than 64 pairs of operands must be submitted to an operation, then internally a sequence of vector instructions with 64 (or less) pairs of operands each is produced (Figure 17).

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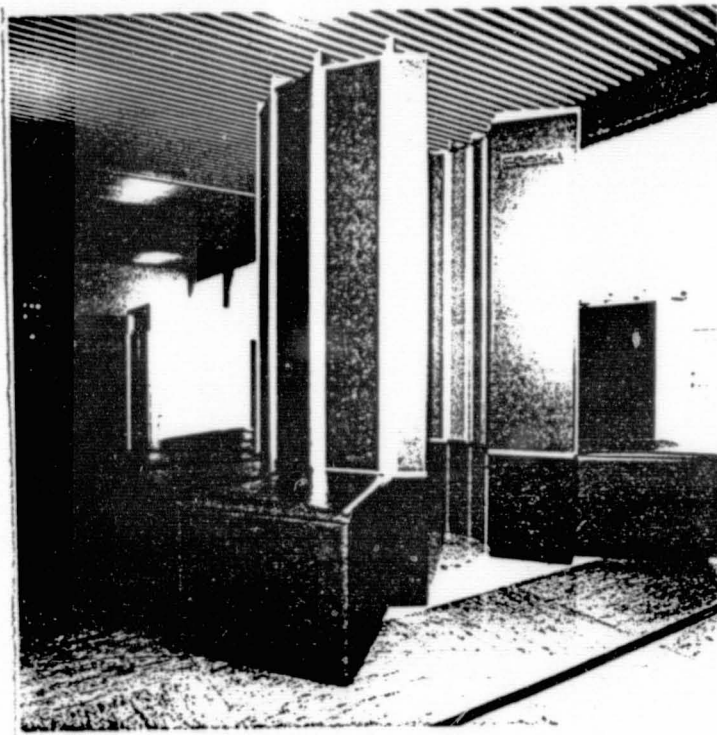


Figure 17: Maximum power computer Cray-1S in the Computer Center of Oberpfaffenhofen.

Once the vector operands are in the register, the "start-up strafe", to fill the segments of the conveyor, must be in the order of magnitude of 10 cycles per vector operation. However a certain bottleneck is the storage band width (one word per cycle). Therefore a programmer who wants to achieve optimum capacity will try to keep the intermediate results to a great extent in the vector registers. As far as possible he will even work simultaneously with the filling and emptying of the vector registers in the functional units.

It may be said with some justification that the "overhead" for the calculation of a vector print-out on the Cray depends greatly on the print-out itself and on the vector length. This dependence together with the relatively low fixed costs is responsible for the unsurpassed capacity of the Cray system for short vectors. If there are no dependences between the operands "chaining" is possible, (that is for example the result of an addition can be used directly for input of a multiplication) addition and multiplication can take place essentially simultaneously. Under optimum conditions therefore two sliding operations can take place per cycle (cycle time 12.5 ns).

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The maximum storage level is 1 Mword for the Cray-1, 4 Mwords for Cray-1S. The Cray-1S can be equipped with an I/O subsystem with great buffer memory and with up to 4 L/O processors.

If we leave aside the calling of special Cray assembler routines, for the FORTRAN programmer there are no problems of transfer, although on the other hand he is advised to restructure as far as possible his

algorithms in the form of vector/matrix. Naturally he does not have to keep in mind long vectors to the extent as would happen with the Cyber.

12.4 Computers of the Near Future

For 1983 the companies Cray, Fujitsu and Hitachi have announced new computers, whose maximum power lies within the range of 250 to 600 MFLOPS (million floating point operations per second). All the computers can be considered as an improvement of the architectural principles of the Cray-1. The principle of the vector register was maintained, even though their size, number and possibilities of configuration vary. The storage band width was increased in all cases to four words per cycle (for the double processor system Cray-XMP to 8 words per cycle) and the cycle time of the pipes reduced considerably in part.

To satisfy the requirements from different areas of application, especially for calculating 3D problems with faster access to large storage areas, for the new vector computer of Hitachi and Fujitsu a main memory structure up to 256 Mbytes and a transmission rate of about 1.25 giga- /124 bytes/second was provided.

Some of the systems show considerable progress in the communications to the front end computer (data access on common plates). But on the user interface also the attempts are visible for improving the convenience for example by aids for interactive vectorization.

For the year 1984 another computer of the Cray Company, the Cray-2 has been announced. This computer which is greatly reduced in its internal dimensions should come on the market as a four-processor system with the nool cooling technology ("liquid immersion") and achieve with its system capacity the gigaflops limits (1 million operations per second).

12.5 The Cray Computer in the DFVLR

The Cray 1S was installed in March, 1983 in the Computer Center of Oberpfaffenhofen. It is connected through a channel coupling with its preliminary computer, the IBM 3081. Through the SNA-network not only all the research centers of the DFVLR, but also the University of Stuttgart and the Juelich Nuclear Research Center have access to the Cray. The installation took place without great problems. After a three month "pilot phase" the computer was officially reduced in June, 1983.

For a more extensive application, for example flow mechanics or structural mechanics, a considerable requirement of temporary plate space must be expected. But only six 300 MByte plates are available, of which moreover part is occupied by system data files, compilers and libraries. Therefore measures have been taken to prevent the filling of the plates.

On the Cray system three types of lifetimes of data files are permissible:

| | |
|---------------------------|--|
| temporary data files | lifetime = lifetime of the job |
| semi-permanent data files | maximum life of 7 days |
| permanent data files | the lifetime is established individually |

With the semi-permanent data files in job chains unnecessary data transfers must be avoided. Permanent data files must be announced to the system manager. He establishes their lifetime. User data files are not ensured on the Cray. The user is responsible himself for securing his data files on the preliminary computer.

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Besides the program library IMSL (digital system and statistics) introduced on all plants of the Central Data Processing at present a few more program libraries optimize at least partly for the Cray (for example EISPACK, LINPACK) are available to the users. The installation of a finite element system and the structure of the library of algorithmic cores optimized for the Cray, which are relevant for the DFVLR are provided.

So far it has not proved to be necessary to introduce the graph software on the Cray. The user can undertake the graphic reprocessing of his data on the preliminary computer or on his site computer. The reprocessing can be connected without manual accesses for calculation on the Cray.

In the second half of May in all research centers of the DFVLR two day introductory courses were held for Cray users. Since the control speed of the Cray is very simple and therefore easy to learn, the users became relatively quickly used to the new computer. The user support for the Cray is provided at all sites by one or two advisors with mathematical-digital training. To promote the information flow between the Cray users and the computer centers and the exchange of experience among the Cray users, responding partners were appointed in the institutes.

Continuing courses are provided if necessary for the fall of 1983. The first results of the Research Range of Flow Mechanics of the DFVLR which were achieved on the Cray could be described already at the official inauguration on June 30, 1983.

13. Data Processing for Management

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13.1 Review of 1967 to 1978

The support of the management of the DFVLR by the automated data processing started in 1967. From the beginning it was affected by serious defects such as the want of adequate aid (for example no COBOL

compiler), too few personnel members in the area of organization, want of programmers in the Computer Center and in the specialized divisions. Nevertheless by the end of 1970 it was possible to implement considerable partial functions in a simple manner in the form of individual stacking programs which were carried out with magnetic tape orientation on the AEG-TELEFUNKEN computer.

Naturally these functions covered only incompletely the requirements of the specialized sections. Therefore the supplier of the following computer in collaboration with the DFVLR had to develop a comprehensive integrated administrative data processing system. AEG-TELEFUNKEN took over this mission for the TR440. When the expected starting time (first January 1973) could not be maintained, the development studies were broken off in the middle of 1973 (cost: about 24 MJ; only the software for the evaluation of the salary and deductions accounting was applicable after adjustment work). The existing programs had to be converted to the new computer system TR440. By modifying the TR440 FORTRAN compiler the TR4-FORTRAN internal code was simulated, to avoid at least a completely new coding.

Subsequently (1975-1976) the processing strategy of the individual programs were modified from sequential (tape oriented) into index sequential or random (plate-oriented). At the same time the program of the Financing Section were coded again in COBOL and in some areas converted to the data bank system DBS440.

After the TR440 was replaced by a Siemens 7.760 plant with the operating system BS2000 (see chapter 1, page 3) in 1977-1978 the programs introduced for the management had to be converted once again. In this connection only an original assembler-interface DBSIMU was developed, /127 with which the data bank system DBS440 could be replaced.

At the end of this phase indeed an extensive software package (about 400 stacking programs) was available but the functional extent did not yet satisfy the requirements of the specialized divisions which had increased since 1970.

13.2 Period between 1979 and 1982

In 1979 they started supporting certain functions by on-line-display screen procedures, to replace the central occupation oriented stacking processing by a decentralized specialty processing. Finally in 1980 it was possible to offer with the budget monitoring system MUES all the people responsible for the budget in the Institute, the main divisions and the management a modern tool for decentralized, selective core of accounting data on the display screen.

In order that the cost calculations (processing and evaluation) could also be supported, a new key system had to be introduced for cost items, cost carriers and types of costs. This implied the reprocessing of many programs and new developments.

With the operational start of the newly developed accounting system for obtaining salary and deductions (1981) the last traces (TR4-FORTRAN) of the boundary conditions pregiven in 1967-1968 were eliminated and the separate program packets introduced until then for salary and deduction calculations (MTB and BAT) were replaced. Thus finally the prerequisites were obtained for the mechanical individual recalculation, that is the calculation of the backward periods in the case of the change of the personal initial data such as for example the characteristics for tax, the social security and medical insurance or classification, which was already required by the personnel since 1967. This function is used in routine operations since January 1, 1983.

13.3 Activities and Goals 1983-1984

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The software for the on-line display screen recording of the salary and deduction calculation data is now being developed. From October 1, 1983 this function will be put into operation. For all data inputs of the personnel then the occupation oriented central mass data recording will be ended.

The transition from the SIEMENS 7-760 plant with the operating system BS2000 to a computer system compatible with the IBM under MVS would have forced once again the DFVLR to change the existing program. Considerations regarding the economy and the desire for expansion of the functional extent lead to the decision to use in the future in the financial sector standard software for the real time processing instead of the programs used up to now and adjusted to the DFVLR's own requirements for stack processing. After this phase (the elimination of the SIEMENS 7-760 BS2000 system is planned for June 30, 1984) the following working regions of the management will be supported by the administrative data processing.

| | |
|---|--------|
| Calculation of salary and deductions | DFVLR |
| Personnel job plans and statistics | DFVLR |
| Financing and office accounting | SAP-RF |
| Budget calculation and monitoring | DFVLR |
| Recording of operating data | DFVLR |
| Calculation of costs, accounting for operations | DFVLR |
| Order section, control of liabilities | SAP-RM |
| Economic plan | DFVLR |
| Planned bookkeeping | SAP-RA |
| Materials and stocks | SAP-RM |
| Planning for personnel capacity | DFVLR |

| | | |
|----------------|---|---------------------|
| DFVLR | = | Our own development |
| SAP-RF/-RM/-RA | = | Standard software |

In the third quarter of 1983 our own computer will be installed for administrative data processing. This system is also included in the DFVLR computer network. By means of this computer the production plant should be stabilized, the availability should be constantly assured day-time and thus the urgently necessary continuity assured on a long-term basis for administrative data processing.

While previously the data processing functions had been developed and installed exclusively for the recording, processing, management, connection and evaluation of operational data, in future the acquisition of strategic data and data structures will be more prominent. The solutions for this purpose are to be sought in information systems (MIS) and documentation data banks, as well as in interrogation languages close to the user and compatible (for example SQL). This is connected with the use of increasingly powerful systems at the workplace.

13.5 Methods of Administrative Data Processing

13.5.1 Software Technique Methods

All software developments and modifications which were conducted under the responsibility of WT-DV-ASO considered according to regulations which contained the detailed instructions for the following elements:

Modularization of the problems,
Exchange of data between the working regions,
Programming languages,
Data management,
Coding,
Test strategy,
Documentation,
Catalogue establishment, archives for the source programs.

These rules are laid down in the handbook "Convention for the Development and Maintenance of Administrative Software".

The important software tools which are used are:

| | |
|----------------------------|--|
| COBOL | for stack applications |
| PL/I | for on-line applications |
| IMS/DB | for data bank management |
| CICS | for display screen control |
| OPUS | for documentation |
| DOKU (DFVLR Development) | for documentation |
| DBSIMU (DFVLR Development) | for simulation of the DBS440 interface |

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13.5.2 Operational Methods

The decentralized on-line functions for

--recording, testing, correction of data;
--updating of the disposition data;
--standard and ad hoc inquiry are supplied daily from 7 a.m. to 6 p.m. under the control of CICS.

From 6 p.m. the standard production activity:

- support point assurances,
- discharge of the log data files,
- establishment of extracts for stack applications,
- mechanical continuation of the on-line data stocks and
- synchronization of the on-line and stack data stocks

are carried out. The central stack functions for:

- the term bound calculations and the exchange of data,
- the establishment of standard reports,
- the mass data processing of marked operating data

are developed simultaneously during the on-line operation. In this connection the competitive writing access to the on-line data stocks are prevented by redundant storage of the data concerned.

Once a month all the stocks, program sources, data set macrosystems and the electron data processing control documents are recorded on magnetic tapes. One set of these record tapes are kept in fire resistant cupboards outside the machine hall. Copies of these tapes are also stored in fireproof cupboards in a building which is located far away. For long-term records and for data carrier exchange a software developed in the agency itself (MULTI) is used which secures the processing on different computer systems (setwise recording, EBCDIC). Assurances of support points take place with the faster manufacturer specific service routines. These magnetic tapes are kept in the machine hall so that they are directly accessible.

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Print-outs of great extent and the printing of special forms takes place through printing strips on an off-line printing station.

13.6 Timetable - Milestone of the Administrative Data Processing in the DFVLR

| | |
|-------------|---|
| 1967 | Beginning of the development of the software (FORTRAN/TR4); |
| 1968 | Finance and accounting (Current account), ordering, job plan; |
| 1969 | Calculation of deduction for BAT workers including overall retroactive calculation (increase of tariff), budget, economic plan, taking over of the DFL and AVA (partly new developments); |
| 1970 | Year-end personnel business, plant accounting (COBOL TR4), materials (COBOL TR4); |
| 1971 - 1972 | Development of software for an integrated administrative data processing system together with AEG-TELEFUNKEN (COBOL TR440); development of an emergency solution for assuring the business capacity by January 1, 1973; |

| | |
|------|---|
| 1973 | Starting planned on January 1, 1973 of the newly developed analog processing system was not possible; middle of 1973: breaking off of the development studies, beginning of the 1 to 1 conversion of the software from TR4 to TR440; |
| 1974 | Conversion studies; |
| 1975 | Salary calculation for MTB workers (take-over of the DESY accounting system); adaptation of the evaluation software developed by AEG-TELEFUNKEN for the salary and deductions accounting; end of the conversion studies TR4 ---TR440 (first quarter); |
| 1976 | Conversion of the programs of the financial sector from FORTRAN to COBOL, in this connection expansion of the extent of the functions; |
| 1977 | Beginning of the 1 to 1 conversion of the software from the TR440 (AEG-TELEFUNKEN) system to the SIEMENS 7.760/BS2000 (April 1, 1977); |
| 1978 | End of the conversion studies (June 30, 1978); |
| 1979 | On-line stock data services for the financial sector (preliminary computer system INFOREX 5000); |
| 1980 | On-line stock data servicing for the personnel; budget monitoring system MUES under (MVS/TSO); adjustment of the software to new cost key system; |
| 1981 | Introduction of the new cost key system, cost calculation, gross/net accounting system for BAT and MTB workers (COBOL); |
| 1982 | Take-over of the on-line stock data service on the IBM (IMS/CICS); |
| 1983 | Individual retroactive accounting for salary and deduction calculation take-over of the budget monitoring system MUES on the MVS/CICS; beginning of the conversion study for the BS2000 software to the IBM/MVS; introduction work for the standard software of the SAP Company (RF for financial accounting, RM for the ordering sector, purchase and stock; RA for plant bookkeeping); on-line recording of the accounting data for salaries and deductions; installation of a separate analog digital processing computer. |

14. Training of Mathematical and Technical Assistants

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The training for mathematic and technical assistants (MaTA) has been supplied in Braunschweig already in 1962, in Oberpfaffenhofen since 1978 and in Goettingen since 1981. The extent to which young people are attracted to this profession is shown by the increasing number of applicants. In 1978 nine persons applied in Oberpfaffenhofen for five jobs, in 1981 there were 18 applicants for 15 jobs of which however 11 were not suitable. In 1983 the 10 positions free had to be filled from 200 applicants.

But the DFVLR will not generally contribute with this supply to the training of young people, it is attempting to cover also its increasing need for programmers in its own organization. As compared with "pure" programmers, the MaTA's trained in the DFVLR had not only the advantage that as a rule they have the better mathematical knowledge, but their data processing training is also adjusted better to the needs of the DFVLR.

The two and a half to three year training process is, for equal requirements for the studied topic, not set up in exactly the same way in the three research centers, in Braunschweig the trainees are accommodated from the beginning in the Institutes and main divisions of the research center and thus are assigned immediately to activities which correspond to the level achieved by them. The basic training in data processing is thus preferred as far as possible. In Goettingen and Oberpfaffenhofen the trainees are distributed among the institutes only after a suitable introduction to the principles of data processing and mathematics.

All trainees work in the institutes on urgent problems, to obtain experience in the handling of programming languages, large computers and digital methods. The theoretical material taught is imparted partly in accompanying, partly in block study. It contains among others the mathematical partial areas of analysis, linear algebra, digital mathematics and the theory of probabilities and gives the trainees an insight into graphic, operating systems, compilers, data file organization and data banks. About 40 percent of the hours of study are used here for mathematics, 60 percent for digital mathematics and data processing.

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The material and hour plans are established according to the directives of the Chamber of Industry and Commerce (IHK) of Ludwigshafen. The lecturers are predominantly DFVLR employees (Table 6).

In Braunschweig not only trainees of the DFVLR take part in the training process. For the eighth course in Braunschweig, which started in 1982 this time four trainees came from the Braunschweig Technical University.

In the last five years it was possible in 1982 for altogether 14 out of 16 trainees, of which 3 from the Braunschweig Technical University, one from the Medical University of Hannover to pass successfully the examination before the IHK of Ludwigshafen. Two MaTA trainees had broken off their training after a long illness and a marriage. In Oberpfaffenhofen in 1981 all MaTA trainees had passed their examination at the IHK. In Goettingen so far no examinations have been conducted.

To be able to offer training continuously in the whole of DFVLR, the training course begins each fall in a different center (1982 Braunschweig, 1983 Oberpfaffenhofen and 1984 Goettingen). At the end of 1982 in the Central Data Processing 27 instructor jobs for mathematical and technical assistants were filled. On September 1, 1983 10 new MaTA's

started their training in Oberpfaffenhofen. Twelve trainees will sit for the examination at the beginning of next year.

| | Braunschweig | Oberpfaf- fenhofen | Goettingen |
|---------------------|--------------|-----------------------|------------|
| WT-DV Workers | 63%* | 70% | 23% |
| Other DFVLR workers | 37%* | 11% | 45% |
| Outside lecturers | ---- | 19% | 32% |

*of which one-third outside regular work time.

Table 6: Distribution of the Hours of Study Among the Lecturers.

Appendix A: Publications, Lectures, Internal Reports 1977 - 1983
(Selection)

/80-562-1/

Bauer, H.

Some Invariance Principles for Stochastic Processes and their Inverse and Supremum Processes.

Mathematische Zeitschrift, Band 175 (1980), pages 283-297, 15 lit.

/81-562-1/

Bauer, H.

On Invariance Principles with Limit Processes Satisfying Strong Laws. Zeitschrift fuer Wahrscheinlichkeitstheorie und verwandte Gebiete, Band 58 (1980), pages 257-265.

/79-562/

Bauer, R.*, Dierstein, R.

Framework Concept for the Systematics of Data Security

GDD - Document Number 19, Data Context Publishing House, Koeln (1979), 67 pages, 8 figures

/77-562-1/

Buchberger, F. J.

Connection in Variant Directive Programs in Communication Systems

DLR-FB 77-38 (1977), 88 pages, 28 figures, 1 table, 26 literature references.

/78-562/

Dierstein, R.

Data Security in Data Bank Systems

Technical Conference of Data Protection DAFTA 1978, Conference Report Data Context Verlag, Koeln (1979), pages 84 to 92.

/80-562-2/

Einert, D., Glas, G.

What is a Virtual Terminal?

Electronische Rechenanlagen Heft 4/80, Oldenbourg Verlag, Munich, 2 pages, 2 figures, 2 tables, 25 literature references.

/81-562-2/

Einert, D., Glas, G.

SNATCH Opens Manufacturers' Networks through Gateways. Proc. Seventh Data Communications Symp., IEEE, Mexico City (1981), pages 44-51, 5 figures

*Technical University, Munich

/82-462-1/

Einert, D., Glas, G.

The SNATCH Gateway: Translation of Higher Level Protocols
Journal of Telecommunications Networks, Computer Science Press, Inc.,
(1983), Vol. 2, Number 1, pages 83-102, 18 figures, 27 literature
references.

/83-562-?/

Deinert, G., Mayerhofer, L.*

Possibilities and Limits of the Gateway Solutions for Opening Closed
Networks

Special Informatic Report 60, "Communication in Distributed Systems -
Applications and Operations", Springer Verlag, Berlin/Heidelberg/New
York, 1983, pages 197-232, 12 figures, 14 literature references.

/78-562-2/

Gersing, J.:

Use of the OS-MVS Operating System in the Technical and Scientific Sector
DFVLR Communication 78-02 "Contributions to the Symposium on "Data
Technology in Astronautics" on 19 January 1978 in Oberpfaffenhofen",
(1978), pages 109-116, 5 figures.

/79-562-1/

Glas, G.

Siemens-TRANSDATA and IBM-SNA Common Features and Differences
Proc. WASCO-Tagung, Munich, 27 April 1979, 13 pages, 23 literature
references.

/80-562-3/

Glas, G.

The SNATCH Project - The Way to the DFVLR Computer Network.
DFVLR Report, Issue 31, 1980; 3 pages, 2 figures, 2 tables.

/82-562/

Glas, G.

Experience with the Opening of the SNA Network
CSMI/TTP Literature Volume 21-040, "The New Standards for Data Communi-
cation", Publishers: G. Maurer, Publishing House: CSMI GmbH Munich, (1982),
pages 49-59, 8 figures.

/79-562-2/

Glas, G., Lode, D.**

Opening of Homogeneous Closed Manufacturer Networks in the Sense of the
ISO Reference Model, on the Example of SNATCH, a Functional Connection
Between Siemens-TRANSDATA and the IBM-SNA Computer Network.
Informatic Special Report 22 "Communication in Distributed Systems";
Springer Publishers, Berlin/Heidelberg/New York, (1979), pages 255-266,
3 figures, 13 literature references.

*Informatik Forum GmbH

**Siemens AG

/83-562-?/

Graml, F.

Representation of a Computer Connection on Example of the Coupling on the SNA and TRANSDATA

Conference book of the technical seminar on "Connecting Systems and Open Communication Networks" of the Plant Economics Institute for Organization and Automation of the University of Koeln (BIFOA), Walberberg bei Koeln, May 6 to 7, 1982, 15 pages, 6 figures, 10 literature references.

/83-562-?/

Graml, F.

SNATCH - Implementation of a Coupling of the SNA and TRANSDATA Network Informatics Technical Report 60, "Communication in Computer Systems - Application and Operation", Springer Publishers Berlin/Heidelberg/New York (1983), pages 178 to 196, 14 figures, 11 literature references.

/83-562-?/

Graml, F.

Implementation of SNA Gateway in the SNATCH Project

CSMI/TTP Documents Volume 31-040, "Standardization Concepts for Local Networks, Network Coupling, Gateway Structures", Publishers: Gerhard Maurer, Publishers CSMI GmbH Munich, (1983), pages 117-131, 8 figures

/83-562-?/

Graml, F.

SNATCH Project - the Connection of SNA with TRANSDATA Networks.

Siemens Telcom Report 6 (1983), number 2, pages 104-108, 4 figures.

/83-562-?/

Graml, F.

Successful Technology Transfer in the Area of Data Technology: Coupling of IBM and Siemens Large Computers in the SNATCH Project

DFVLR Report Number 40, (1983), 3 figures.

/82-562-2/

Graml, F.; Urschinger, W.

SNATCH Open TRANSDATA

Conference Book of the Thirteenth WASCO Conference, March 31 to April 3, 1982, Budapest, Hungary, pages 58 - 78.

/79-562-3/

Hoffmann, H.

Processing of AIDS Flight Recorder Data for Quick-Look with a Hybrid Computer System.

In: DFVLR Communications 79-03 (1979), pages 345-362, 10 figures.

/77-562-2/

Kweta, W.; Misar, K.

World Map in True Surface Projection.

DFVLR Nachr. (1977) 21, page 866, 1 figure.

/77-562-3/

Melnikow, M.

Background Memory Management in Operating Systems for Communication Computers

DLR-FB 77-37 (1977), 55 pages, 14 figures, 20 literature references.

/78-562-1/

Saxena, Harish C.

Coupling of IBM and Siemens Systems on RJE Basis as Implemented in Regional Computer Center for The Universities of Mannheim and Heidelberg
DFVLR Paper 78-02 "Contributions to the Symposium on "Data Technology in Astronautics" on January 19, 1978 in Oberpfaffenhofen, pages 97-108, 3 diagrams, 8 literature references.

Appendix 2: Lectures

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/77-562-4/

Dierstein, R.

The Federal Law of Protection of Data and its Effects on the Technical Organization of Personal Information Systems.

First GI User Talk "Computer Supported Personal Information Systems in Economics and Management", Koeln, January 27 to 28, 1977.

/80-562-4/

Dierstein, R.

Privacy and Security

Australian Computer Society, Melbourne, Australia, August 7, 1980.

/80-562-5/

Gentzsch, W.*, Mueller-Wichards, D.; Weiland, C.*

Possibilities and Problems in the Application of Vector Computers, Represented on the Digital Treatment of Some Flow Physical Problems.

DFVLR Workshop "Large Computers" Bad Honnef, March 31 to April 1, 1980.

/80-562-6/

Glas, G.

Compatibility of Manufacturer Network Concepts on Example of SNA and TRANSDATA

GI Special Conference on Data Processing Management, Bonn, April 10 to 11, 1980.

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Glas, G.

The SNATCH Project, a Way to Open Networks.

Computer Center of the Mannheim University, April 15, 1980.

*Institute for Flow Mechanics of the DFVLR.

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Glas, G.

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GMD Computer Center, Birlinghoven, June 4, 1980.

/80-562-9/

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Glas, G.

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Computer Center of the Mannheim University, December 16, 1980.

/81-562-4/

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Working Talk "Exchange of Information through Current Network Projects", GI Special Commission 3/4 (Technical Group of Computer Networks), Mannheim University, November 27, 1981.

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The SNATCH Project

Information Exhibition "IBM/Siemens Computer Connection", Computer Center of the Mannheim University, February 17, 1981.

/81-562-7/

Graml, F.

The SNATCH Project, a Way to Connection of Functions Between IBM/SNA and Siemens/TRANSDATA Computer Networks

mbp seminar "SNA Training Special", Munich, March 23 to 26, 1981.

/81-562-8/

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Architectural Aspects of Computer Networks/Coupling of Manufacturers Computer Networks/ The DFVLR Project SNATCH (SNA and TRANSDATA Coupling of Hosts)

Series of lectures in the Institute for Computing Procedures of the CAE in Xian, China, November 4 to 11, 1981.

/82-562-3/

Graml, F.

Representation of a Connection of Computers on the Example of the Coupling

/143

/144

of SNA and TRANSDATA

Technical Seminar on "Connected Systems and Open Communication Networks" of the Operation Economics Institute for Organization and Automation of the University in Koeln (BIFOA), Walberberg bei Koeln, May 6 to 7, 1982.

/82-562-4/

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The Extent of the Functions of the Image Forming System SNATCH Workshop "Computer Couplings" of the Association for Radiation and Environmental Research (GSF), Neuherberg, July 22, 1982.

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The Coupling System SNATCH as a Siemens Product
Twenty-first Session of the Working Group 6 of the Siemens User Association SCOUT, Bremen, November 15, 1982.

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Implementation of the SNATCH Gateways in Accordance with the Partial Project SNATCH-Pol
Information Exhibition of the Federal Ministry of the Interior (BMI), the Federal Criminology Office of Wiesbaden and the District Criminology Offices of Hessen and Rheinland-Pfalz, Wiesbaden, November 23, 1982.

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Graml, F.

Manufacturers Specific Computer Network on Example of SNA and TRANSDATA
Round Talk of the German Research Association (DFG) on Computer Networks for the Supply Sector of the University, Bonn-Bad Godesberg, November 29 to 30, 1982.

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Graml, F.

Opening of SNA Towards TRANSDATA through the SNATCH Gateway
Information Exhibition "Open Networks" of the Southern Training Center of the IBM Deutschland GmbH, Duesseldorf, April 29, 1983.

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Kortuem, W.*, Lehner, M., Richter, R.* (Lecturer: W. Kortuem)
Multibody Systems Containing Active Elements: Algorithmic Generation of Linearized System Equations, System Analysis and Order Reduction IUMTAM Symposium on Dynamics of Multibody Systems, Munich, August 29 to September 3, 1977.

/81-562-11/

Mueller-Wichards, D.

Practice of Mathematicians
Colloquium at the Mathematics Institute of the Oldenburg University, December 17, 1980.

*Institute of Dynamics of Flight Systems, Oberpfaffenhofen.

/80-562-11/
Mueller-Wichards, D.
Large Computer Architecture
Center Colloquium in Stuttgart, May 8, 1980.

/82-562-6/
Mueller-Wichards, D.
Comparative Benchmarks on Vector and MIMD Computers.
MIMD Seminar, Mannheim University, May 13 to 14, 1982.

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Comparisons of Power Between Vector and Parallel Computers.
Large Computer Seminar of DFVLR, Oberpfaffenhofen, September 8, 1982.

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Mueller-Wichards, D.
Comparisons of Capacity Among Different Vector and Parallel Computers on
the Basis of Different Flow Mechanical Programs.
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Comparisons of Capacity Between Vector and Parallel Computers.
Symposium of the Scientific Computer Center of Berlin (WRB), Berlin,
November 5, 1982.

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Sellmair, P.; Scharfy, M.*
Graphic Data Processing in the DFVLR
Ninth WASCO Conference, Mannheim, April 10 to 11, 1980.

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Urschinger, W.
Coupling of IBM and Siemens Computer by SNATCH
Information Exhibition, "Computer Couplings", Siemens AG, Neuperlach,
October 21, 1981.

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Urschinger, W.
SNATCH as a Possibility for Solution of Coupling of IBM and Siemens Com-
puter Networks
Information Exhibition "Heterogeneous Computer Networks", Siemens AG,
Neuperlach, October 28, 1981.

*Computer Center Bau GmbH (RZB), Stuttgart.

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Urschinger, W.

Implementation of SNATCH

Information Exhibition of the Main Division of Central Data Processing
of DFVLR on the Occasion of the Fourth Session of the Planning Group of
the "German Research Network", Oberpfaffenhofen, September 14, 1982.

/81-562-14/

Wiegand, K.

Front End Computing

SEAS SHARE European Association, Spring Technical Meeting 1981, Bari,
Italy, April 10, 1981.

Appendix 3: Internal Reports

/81-562-15/

Bienasch, R.

Description of the Large Computer Interface Routine for the Intertask
Communication on IBM/7

Memo HA-RZ Goe Nr. 87, (1981), 14 pages, 1 table.

/77-562-9/

Bloeck, I.

On-Line Program to Evaluate the Measurements of Pressure Distribution
on the Transsonic Wind Tunnel

Memorandum HA-RZ Goe 7 (1977), 40 pages, 5 figures, 16 tables.

/80-562-13/

Buchberger, F. J., Wallner, G.

Background Memory Management

Internal Report 535-80/1, 18 pages, 1 figure.

/79-562-14/

Fruehling, W.

Proposal for a Data Processing Concept on Transsonic Wind Tunnel.

Internal Report Memo HA-RZ Goe 58 (1979), 15 pages.

/79-562-17/

Fuetterer, H.

Concluding Critical Report on Data Technology in the Low Velocity Wind
Tunnel in Braunschweig.

Internal Report Memo HA-RZ Goe 38 (1979), 53 pages.

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/79-562-18it./

Fuetterer, H.

Process Computer Concept in FZ-Goettingen

Internal Report Memo HA-RZ Goe 48 (1979), 28 pages, 5 figures.

/77-562-12/

Fuetterer, H., Fuijkschot, P.

Preliminary Design Specification for the DNW Data Acquisition and Con-
trol System.

Internal Report 230-77/02 (1977), 122 pages, 6 figures, NLR Internal
Report AW 77-05 (1977).

/77-562-15/

Grohne, D.

A Representation in the Form of Data of the Surfaces of Given Bodies for the Purpose of Further Processing and Especially Consolidation of the Surface Points by Means of Spline Interpolation.

Internal Report 230-77/RO2 (1977), 14 pages, 14 pages of appendix.

/81-562-22/

Klusowski, E.*, Mueller-Wichards, D., Niedbal, N.*, Uerlings, P.*

On the Determination of the Generalized Mass and the Damping Coefficient in the Stand Vibration Test

Internal Report 232-81JO5, (1981), 78 pages, 17 figures, 9 tables, 12 literature references.

/78-562-17/

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Proposal for the Treatment of Curves and Surfaces

Internal Report 230-78/RO2 (1978), 21 pages.

/79-562-28/

Mueller-Wichards, D.

Calculation of Intermediate Profiles of a Rotor Blade Tip by Means of Splines.

Internal Report Memo HA-RZ Goe 34 (1979), 37 pages, 3 figures.

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/79-562-29/

Mueller-Wichards, D.

Design for a Program for Time Dependent Graphic Representation of Complex Structures.

Internal Report 230-79-RO1 (1979), 88 pages, 5 figures.

/82-562-11/

Mueller-Wichards, D.; Gentzsch, W.**

Performance Comparisons among Several Parallel and Vector Computers on a Set of Fluid Flow Problems.

DFVLR 1B 262-82 R 01

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Mueller-Wichards, D., Gentzsch, W.**; Weiland, C.**

Benchmark Results on Physical Flow Problems with CDC and Cray Vector Computers

DFVLR iB 221 - 82 A 02

*Institute for Aeroelasticity

**Institute for Technical Flow Mechanics.

/81-562-17/

Mueller-Wichards, D., Gentzsch, W.*, Weiland, C.*

Possibilities and Problems in the Application of Vector Computers, Represented on the Digital Treatment of Some Flow Physical Problems.
Internal Report 221-81A05, (1981), 60 pages, 73 literature references.

/77-562-21/

Oppermann, R.

DECNET for Process Computer Coupling in the FZ Goettingen.

Memorandum HA-RZ Goe 5 (1977).

/78-562-18/

Oppermann, R.

Considerations on the Structure of a Process Computer Large Computer Coupling on the IBM System 7

Memorandum HA-RZ Goe Nr. 9 (1978), 21 pages, 3 figures.

/150

/79-562-31/

Oppermann, R.

Multi-User Protection Under RSX-11 M

Internal Report Memo HA-RZ Goe 45 (1979), 18 pages, 1 table.

/77-562-23/

Pohlmann, H.

Computer Coupling TR440 - IBM 370-158 for Dialogue and Stack Operation.

Internal Report 230-77/RO4 (1977), 24 pages, 2 figures, 2 tables.

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Saager, P.

Solution of Elliptical Partial Differential Equations by Means of the Hybrid Computer EAI 600

Internal Report 130-79/1 (1979), 31 pages, 8 figures, 4 literature references.

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Sagrauske, W., Ossig, M., Wittkopf, G.

Introduction into the Tridimensional Graphic Software GINO-F on the Basis of Examples.

Internal Report 130-80/3, 79 pages.

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Semmelrodt, L.

The Benson Plot Software for Operation with Code Independent of Instruments.

Memorandum HA-RZ Goe Number 6 (1978), 18 pages.

*Institute for Technical Flow Mechanics.

The hardware and software of the Central Data Processing Main Division are set up and installed in such a way that the most uniform possible capacities especially in general the same user interfaces can be offered to the users at all sites. Therefore in four sites operating systems of the IBM were installed on all plants, independently of whether they came from Siemens or IBM. In Koeln-Porz in 1982 the IBM operating system VM/370 was released for scientific users. The only exception from this general rule is the data processing system for the SNATCH project.

Table 7: Survey of the Plants and Systems of Central Data Processing

| <u>Research Center</u> | <u>Electron Data Processing Plant</u> | <u>Purpose</u> | <u>Operating System</u> |
|------------------------|---|--|-----------------------------|
| Braunschweig | Siemens 7.870 | Production | IBM MVS-SE |
| Goettingen | Siemens 7.865 | Production | IBM MVS-SE |
| Koeln-Porz | Siemens 7.536 | Analog digital transfer pro- duction (by 1984) | Siemens BS2000 |
| | IBM 4341 | Production SNA carrier | IBM VM-SP IBM MVS |
| Stuttgart | Siemens 7.551 | Production | Siemens BS2000 |
| Oberpfaffenhoven | IBM 3081 | Production | IBM MVS-SP |
| | CRAY 1/S | Production | COS |
| | Siemens 7.865 | Development | IBM VM-SP |
| | | Development and back-up | IBM MVS-SP |
| | Siemens 7.738 | SNA carrier | IBM DOS-VSE |
| | | SNATCH | Siemens BS2000 |

The users can have access in all centers in dialogue and stack operation both to the local data processing system and to the central large computer in Oberpfaffenhoven. The system in Stuttgart will be operated until 1984 in a user association with the Computer Center Bau GmbH (RZB), Stuttgart.

In all plants with IBM operating systems the user interface available is the programming system SPF Structured Productivity Facility. The user software will also be provided uniformly for all systems insofar as this is possible and reasonable. The standard program libraries are uniform at all sites:

| | |
|---------|---|
| GINO-F | Graphic |
| RZLIB | Mathematical Methods |
| IMSL | Mathematical and Statistical Library |
| LINPACK | Linear Algebra |
| LLSQ | Methods of Least Squares |
| EISPACK | Eigenvalue Problems |
| ITPACK | Iteration Method for Weakly Occupied Matrices |
| BSPLINE | Interpolation with Approximation |
| HAROPT | Optimization Method |

Certain program packets for very definite problems are only installed on one site and namely on the data processing system on which they can be operated most economically. There they are directly available also to the users of other sites through the computer network. Examples of such programs are ASKA, a program system for calculating the static and dynamic behavior of elastic and elastic-plastic structures (only in Braunschweig) or the APT, a program system for automatic control of machine tools (only in Koeln-Porz and Goettingen).

Figure 2 on page 9 gives a first survey as to which plants of the Central Data Processing are installed in the five research centers of the DFVLR and how they are connected with each other. In the following section the most important parts of the equipment are indicated individually.

Appendix B.1: Braunschweig

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Central Units

1 Siemens 7.870 with 8 MBytes main memory and 6 channels
Cycle time 70 ns
Average computer capacity 2.9 MIPS

Memory

18 plate running units with altogether 5.7 GBytes
6 tape units 9 tracks 800/1600 and 1600/6250 bpi

Input and Output Instruments

1 punched card reader, 1 printer (2000 lines/minute)
1 on-line plotter, 1 off-line plotter

Connected Computers

1 VAX11/750 in DEC connection with direct access to the site computer

Terminal Instruments

3 stations for remote job entry
66 terminals for the user-dialogue operation with 6 hard copy printers,
8 for graphs.

Software

Operating system MVS release 3.8C (MVS/SCP)
Connection to the DFVLR computer network through SNA

Special User Software

DCF + GML Text processing system (document composition facility
with generalized mark-up language.
about 5,000 individual user programs

Appendix B.2: Goettingen

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Central Unit

1 Siemens 7.865 with 8 MB main memory and 6 channel cycle time 70 ns
Average computer capacity 1.9 MIPS

Memory

10 plate running units with altogether 3810 MBytes
4 tape units 9 track, 1600/6250 bpi

Input and Output Instruments

1 punch card reader/puncher, 2 printers (1200 lines/minute)
1 punched strip reader, 2 plotters, 1 laser printer IBM 6670

Connected computers

8 DEC PDP 11
1 VAX 11/750 in the DEC connection with direct access to the site
computer

Terminals

1 station for remote job entry
73 terminals for the user dialogue operation, of which 3 with
hard copy printers, 7 for graphs

Software

Operating system MVS release 3.8C (MVS/SCP)
Connection to the DFVLR Computer Network through SNA

Special User Software

| | |
|-----------|---|
| APT | Automatic control of machine tools |
| REDUCE | Processing of algebraical expressions |
| DCF + GML | Text processing system (document composition facility with generalized mark-up language) |

Appendix B.3: Koeln - Porz

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Production System

Central Unit

1 IBM 4341-LO1 with 4 MBytes main memory and 5 channel cycle time
120 ns
Average computer capacity 0.8 MIPS

Memory

5 plate running units with altogether 3,170 MBytes
4 tape units 9 track, 1600/6250 bpi

Input and Output Instruments

1 punched card reader, 2 printers (360 lines/minute)
1 printer (1100 lines/minute)

Terminals

50 terminals for the user dialogue operation, of which 3 for graphs

Software

VM/SP operating system
REPORT information system
Connection to the DFVLR Computer Network through SNA (via MVS)

Special User Software

APT Automatic control of machine tools
QUICKDRAW Drawing of the flow diagrams of source programs

about 1,500 individual user programs.

System for the Administrative Data Processing

In the local computer center of Koeln - Porz another plant is installed which is used exclusively for administrative data processing.

Central Unit

1 Siemens 7.536 with 2 MB real memories and 6 channels
Cycle time 785 ns (writing) and 615 ns (reading)
Average computer capacity 1.0 MIPS

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Memory

7 plate running units with altogether 2676 MBytes
3 tape units, 9 track, 1600/6250 bpi

Input and Output Instruments

1 punch card reader, 1 printer (1200 lines/minute)
1 punch strip reader, 1 punch strip puncher, 2 on-line plotters

Terminals

11 terminals for the user dialogue operation

Software

- Siemens BS2000 operating system
- Network software Siemens PDN
- Data bank system FIDAS of the Association for Mathematics and Data Processing (GMD)

Appendix B.4: Stuttgart

These plants will be operated until 1984 jointly with the Computer Center Bau GmbH (RZB).

Central Unit

- 1 Siemens 7.551 with 4 MByte main memory and 4 channels
- Cycle time 785 ns (writing) and 615 ns (reading)
- Average computer capacity 1.0 MIPS

Memory

- 10 plate running units with altogether 2,100 MBytes
- 5 tape units 9 track, 800/1600 and 1600/6250 bpi

Input and Output Instruments

- 1 punch card reader, 2 printers (960 lines/minute)
- 1 punch card puncher, 1 punch strip reader, 1 punch strip puncher
- 1 floppy disk unit, 1 on-line plotter, 1 off-line plotter

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Terminals

- 1 printer
- 2 stacking stations
- 39 terminals for user dialogue operation, of which 4 for graphs

Software

- Operating system BS2000 variant 5.0 K
- Connection to the DFVLR Computer Network through SNATCH

Special User Software

- Siemens MEB method bank (mathematical subprogram)
- about 5,000 individual programs of the user

Appendix B.5: Oberpfaffenhofen

Production System

Central Unit

- 1 IBM 3081 K-24 with 2 processors, 24 MB main memories, 16 channels
- Cycle time 32.5 ns
- Average computer capacity 16.0 MIPS

1 CRAY 1/s with 8 MBytes main memory and 12 channels
Cycle time 12.5 ns
Average computer capacity 80.0 MIPS

Memory

/158

2 drum memories with altogether 22 MBytes
30 plate running units with altogether 9,502 MBytes
1 mass memory with 8 plate running units with altogether 1,600 MBytes and a library with altogether 236,000 MBytes
7 tape units 9 track 800/1600 bpi or 1600/6250 bpi
1 tape unit 7 track 556/800 bpi

Input and Output Instruments

1 punch card reader, 1 printer (1200 lines/minute)
1 on-line plotter, 1 off-line plotter, 1 card puncher

Connected Computers to the IBM 3081

1 CRAY 1/S
1 PDP 11/34 in DEC connection
1 each of Wang (NE-PA), HP 9845 (NE-HF), Krantz-Mulby (WT-DA), Interdata 8/32 (WT-DA), LSI 11 (WT-DA), Intel (WT-RM), PDP 11-24 (WT-DV), Siemens 7.551 (RZS), Siemens 7.536 (RZK) through RJE emulation
1 each Siemens 7.870 (RZB), Siemens 7,865 (RZG), Siemens 8.865 (RZO) and IBM 4341-LO15 (RZK) in SNA connection

Terminals

7 stations for remote job entry in Oberpfaffenhofen and Koeln - Porz
122 terminals for user dialogue operation of which 10 with hard copy printers, 8 for graphs
50 of these terminals are installed outside Oberpfaffenhofen

Software

Operating system OS/MVS-SP for IBM 3081
Operating system COS (CRAY Operating System) for CRAY 1/S
Mass storage management Hierarchical Storage Manager (HSM)
Data bank system CICS OS/VS and IMS-DB
Network software OS/VS-NCP, ACF-VTAM and NJE Release 3.1

Special User Software

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| | |
|--|--|
| DCF + GML | Text processing system (document composition facility with generalized mark-up language) |
| REDUCE | Processing of algebraical expressions |
| Graneda | Graphic Representation of network plan |
| SAS | Statistical Analysis |
| ASKA | Calculation of the static and dynamic behavior of elastic or elasto-plastic structures |
| about 10,000 individual programs for users | |

For system development and maintenance in Oberpfaffenhofen another data processing system is available. This system is simultaneously the back-up system in case of failure of the IBM 3081 production computer.

Development System

Central Unit

- 1 Siemens 7.865-2 with 12 MBytes main storage and 6 channel
- Cycle time 59 ns
- Average computer capacity 2.0 MIPS

Storage

- 6 plate running units with altogether 3,810 MBytes (for OS/MVS)
- 3 plate running units with altogether 1,610 MBytes (for VM/370)

Input and Output Instruments

- 1 printer (1200 lines/minute)

Terminals

- 19 terminals for user dialogue operation, including 1 instrument for graphs

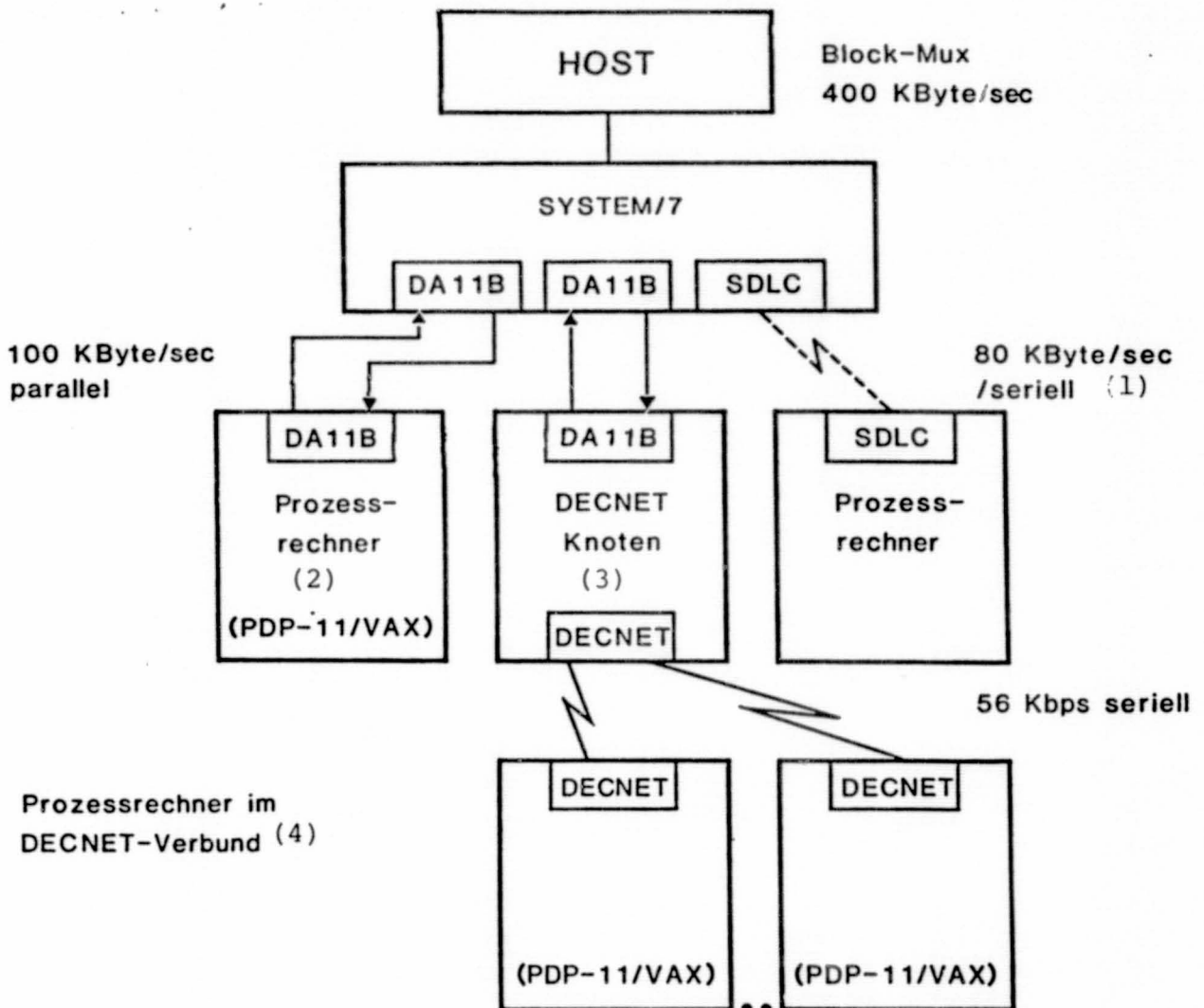
Software

- Operating system VM/SP
- Operating system MVS/SP
- DOS/VSE as SNA carrier system
- Data bank system CICS/DOS with the structured query language SQL
- Network software for communication between the OS/MVS and VM/SP systems

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Moreover in Oberpfaffenhofen a special data processing system has been installed for the SNATCH project, a Siemens plant 7.738 with 1 MByte real storage, 7 plate running units, 1 tape unit, input/outlet periphery in a series of terminals. This system is only available for the work on the project.

Process Computer + Coupling to the Large Computer



Key: (1)series; (2)process computer; (3) DECNET nodes; (4)DECNET process computer.

Communication Computer Functions
System/7:

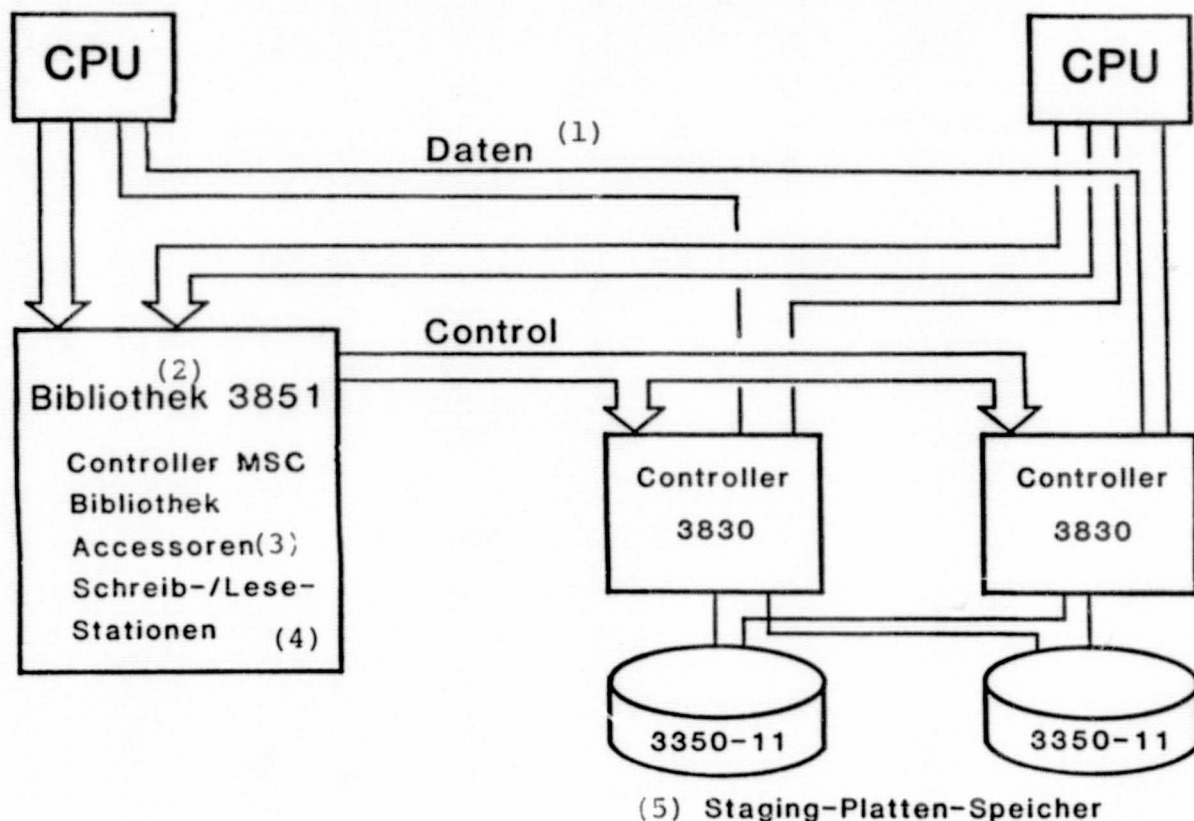
- Data concentrator
- Data multiplexer
- Channel connection to host
- Up to 16 process computers can be connected through DA11B interface
- SDLC connection being prepared
- DACOS operating system

DECNET Nodes

- Network nodes for DECNET
- Data multiplexer
- DACON operating system

Coupling Functions

- HOST/Process computer intertask communication
- Fast data transfer
- Transparent data transmission



Key: (1) data; (2) library; (3) accessories; (4) reading/writing stations; (5) staging plate storage.

Advantages

Mass data storage and availability under control of the operating system
 Speed of data transfer similar to the plate
 Cost per MB between tape and plate

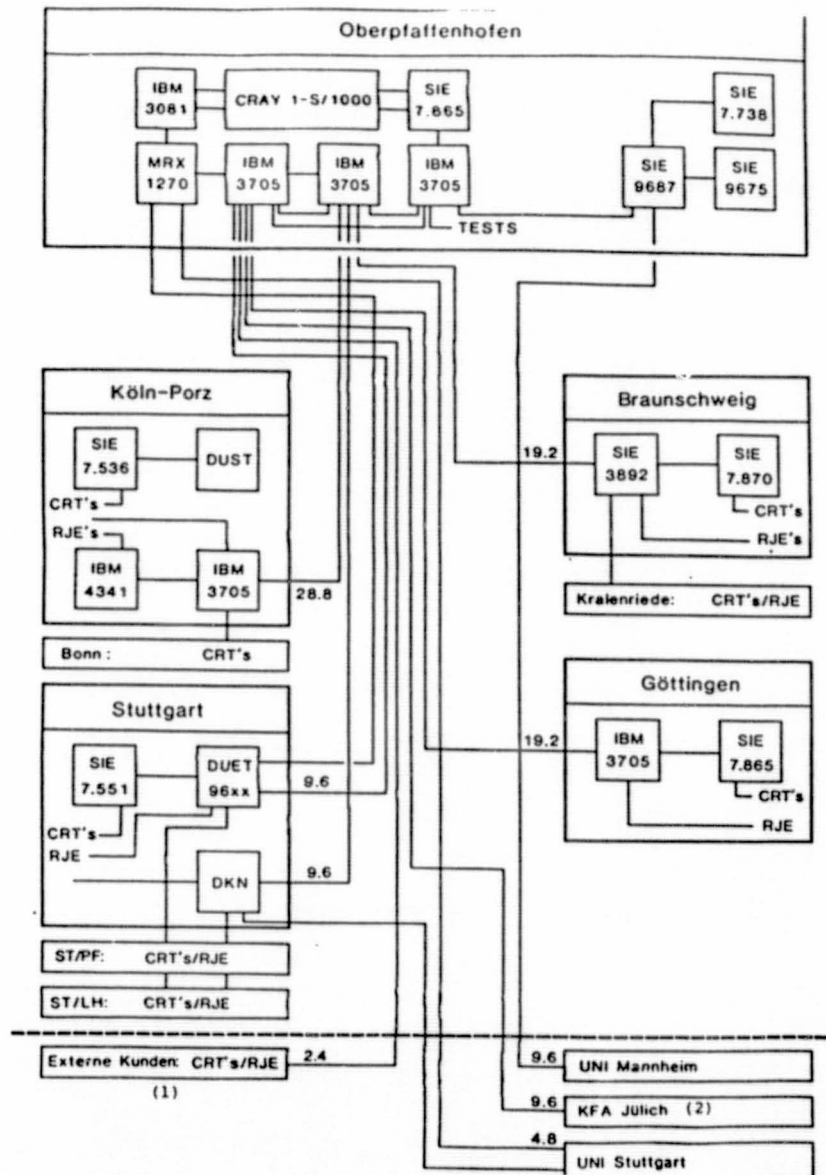
Functions

Availability of selective data sets of the virtual volume on plate unit (staging)
 Data file plate management on staging plates
 Storage away on cartridges (destaging)

Equipment

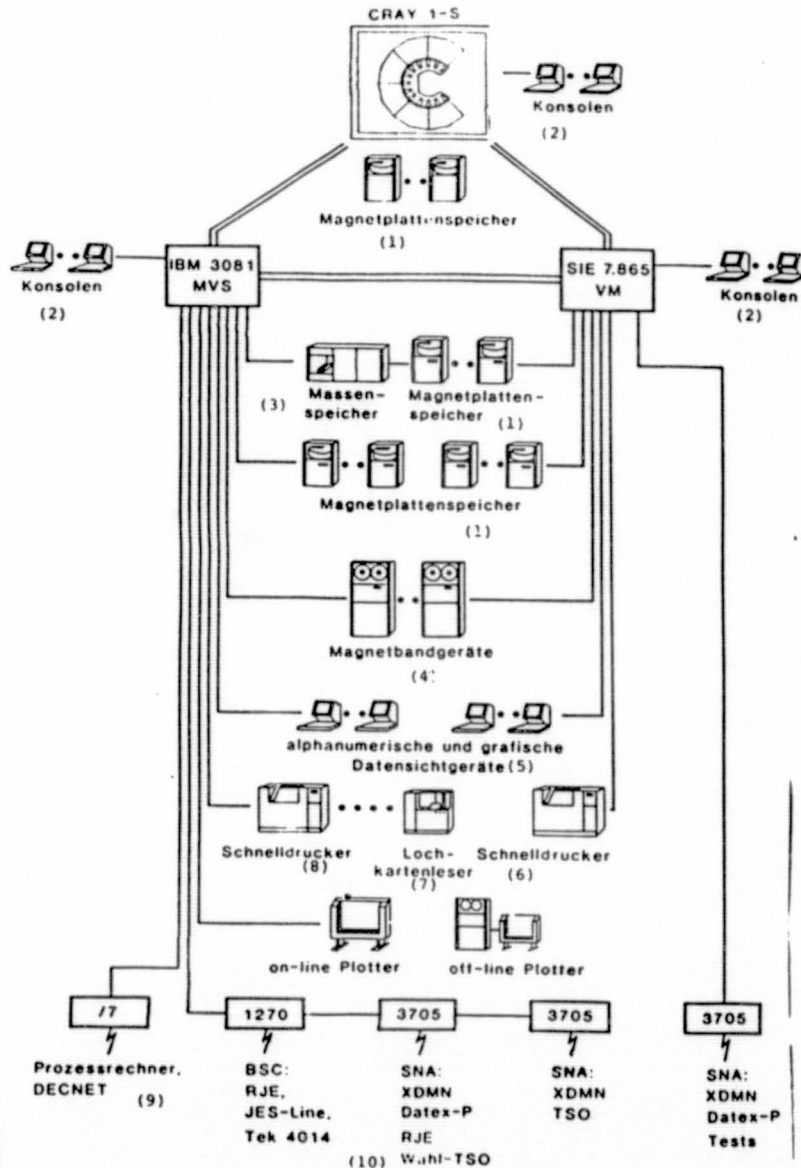
| | |
|--------------------------|---------------------------------------|
| Model | A22 |
| Storage capacity | 4720 cartridges of 50.4 MB 237,888 MB |
| Writing/reading stations | 4 |

TP Network



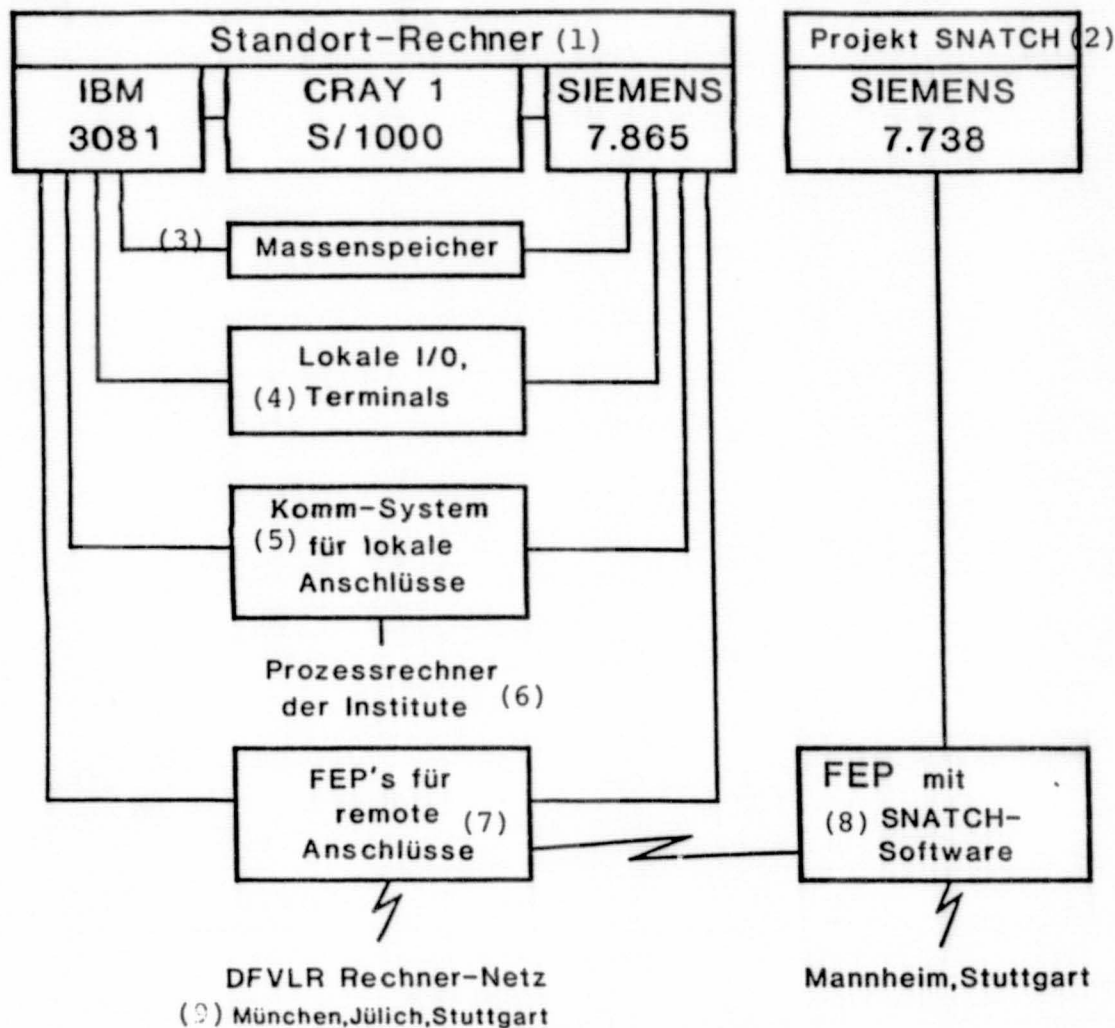
Key: (1)external clients; (2)Juelich Nuclear Research Center.

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Key: (1) magnetic tape storage; (2) consoles; (3) mass storages;
(4) magnetic tape instruments; (5) alphanumerical and graphic data
visualization instruments; (6) fast printer; (7) punched card reader;
(8) process computer; (9) selection.

Data Processing in the Oberpfaffenhoven Computer Center



Key: (1)site computer; (2)SNATCH Project; (3)mass storage; (4)local input/output terminal; (5) communication system for local connections; (6)process computer of the institutes; (7)FEP for remote connections; (8)FEP with SNATCH software; (9)DFVLR Computer Network, Munich, Juelich, Stuttgart.

Functions of the Site Computer

Program development in timesharing
Administrative dialogue applications
Graph on display screen and plotter
Data bank systems
Nodes of the DFVLR Computer Network
Central stack processing computer
with high capacity

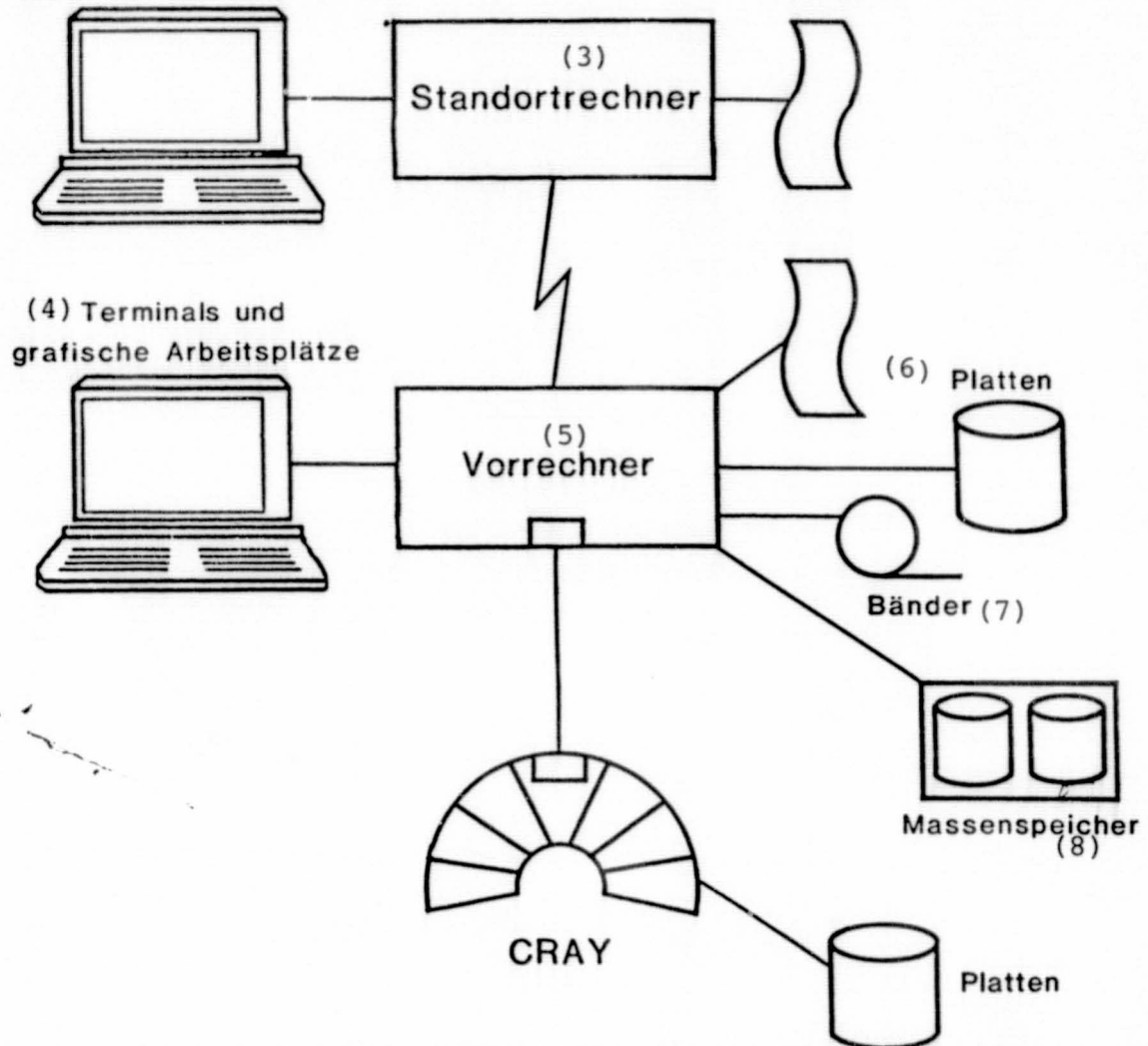
Mass data processing
Data holding and security
Text processing
Test and development systems for
operating system modifications
Functions of the SNATCH Computer

Coupling of the BS2000/Transdata
with IBM/SNA Network

Embedding of the CRAY 1S in the DFVLR Computer Environment

(1) Terminals und
grafische Arbeitsplätze

(2) Druck- und
Plotausgabe



Key: (1)terminals and graphic workplaces; (2)printing and plotting output; (3)site computer; (4)terminals and graphic workplaces; (5)preliminary computer; (6)plates; (7)tapes; (8)mass storage.

Role of the Site and Preliminary Computer Connected with the CRAY

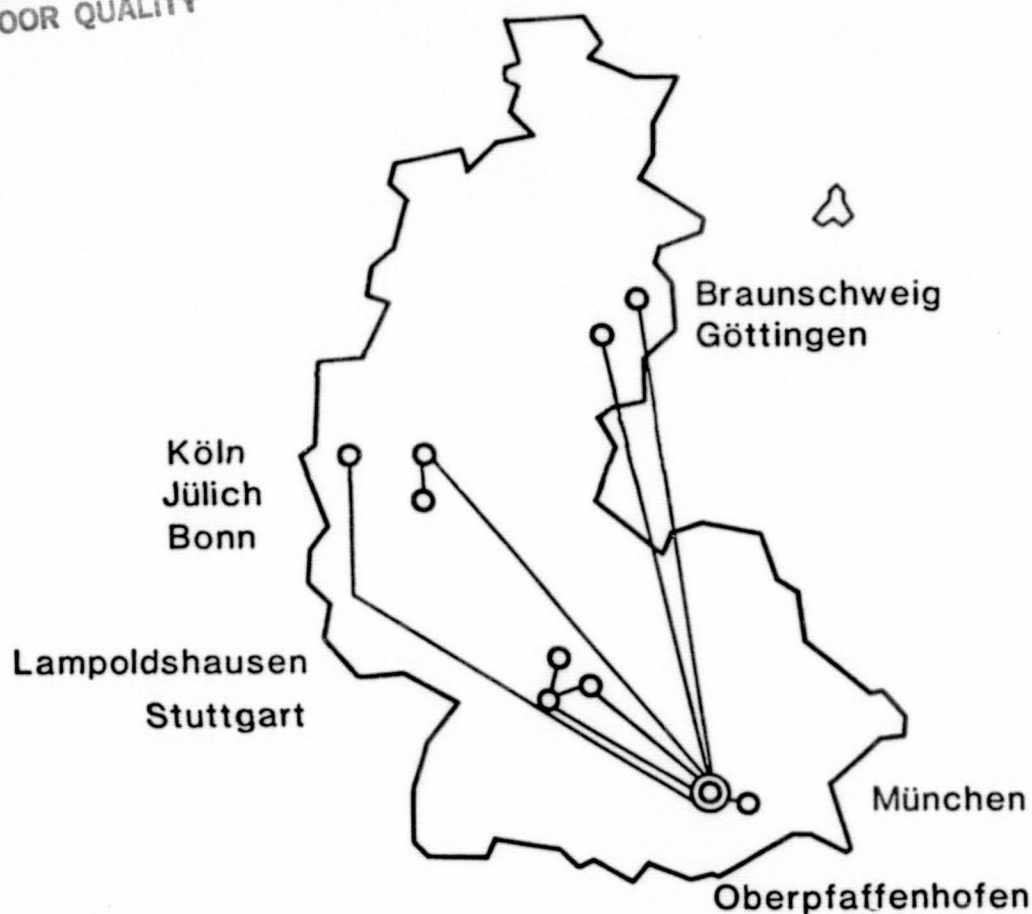
Program development, management of data and programs, job submit for CRAY, output of CRAY results, graphic reprocessing.

Role of the CRAY in the DFVLR Computer Connection

High speed arithmetic for problems with intensive computer needs from: flow mechanics, structural mechanics, meteorology, flight mechanics, image processing; plate placed for working data files and CRAY-specific program libraries.

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DFVLR Computer Connection



| <u>Site</u> | <u>Data Processing System</u> | <u>Connection</u> |
|------------------|---------------------------------------|--|
| Oberpfaffenhofen | CRAY 1-S IBM 3081 Siemens 7.865 | |
| Braunschweig | Siemens 7.870 | SNA-Cross Domain 19.2K |
| Goettingen | Siemens 7.865 | SNA-Cross Domain 19.2K |
| Stuttgart | Siemens 7.551 | SNATCH 9.6K RJE 9.6K Remote TSO 9.6K |
| Koeln | IBM 4341 Siemens 7.536 | SNA-Cross Domain 28.8K |